General Report

Survey of India

1887-88 & 1888-89

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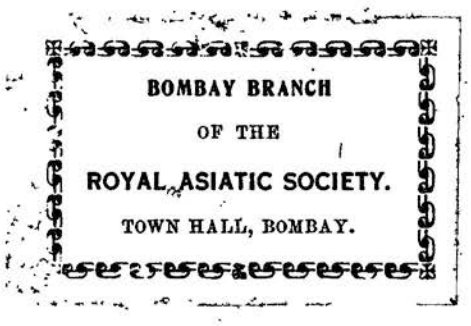

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Survey of India Offices, Calcutta, January 1889

Photo-etching

THE SURVEY OF INDIA OFFICES CALCUTTA

(Completed 1888.)

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India Department

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1887-88.

d 1888-89

134599

PREPARED UNDER THE DIRECTION OF

COLONEL H. R. THUILLIER, R.E.,

SURVEYOR-GENERAL OF INDIA.

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CALCUTTA:
PRINTED BY THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
1889.

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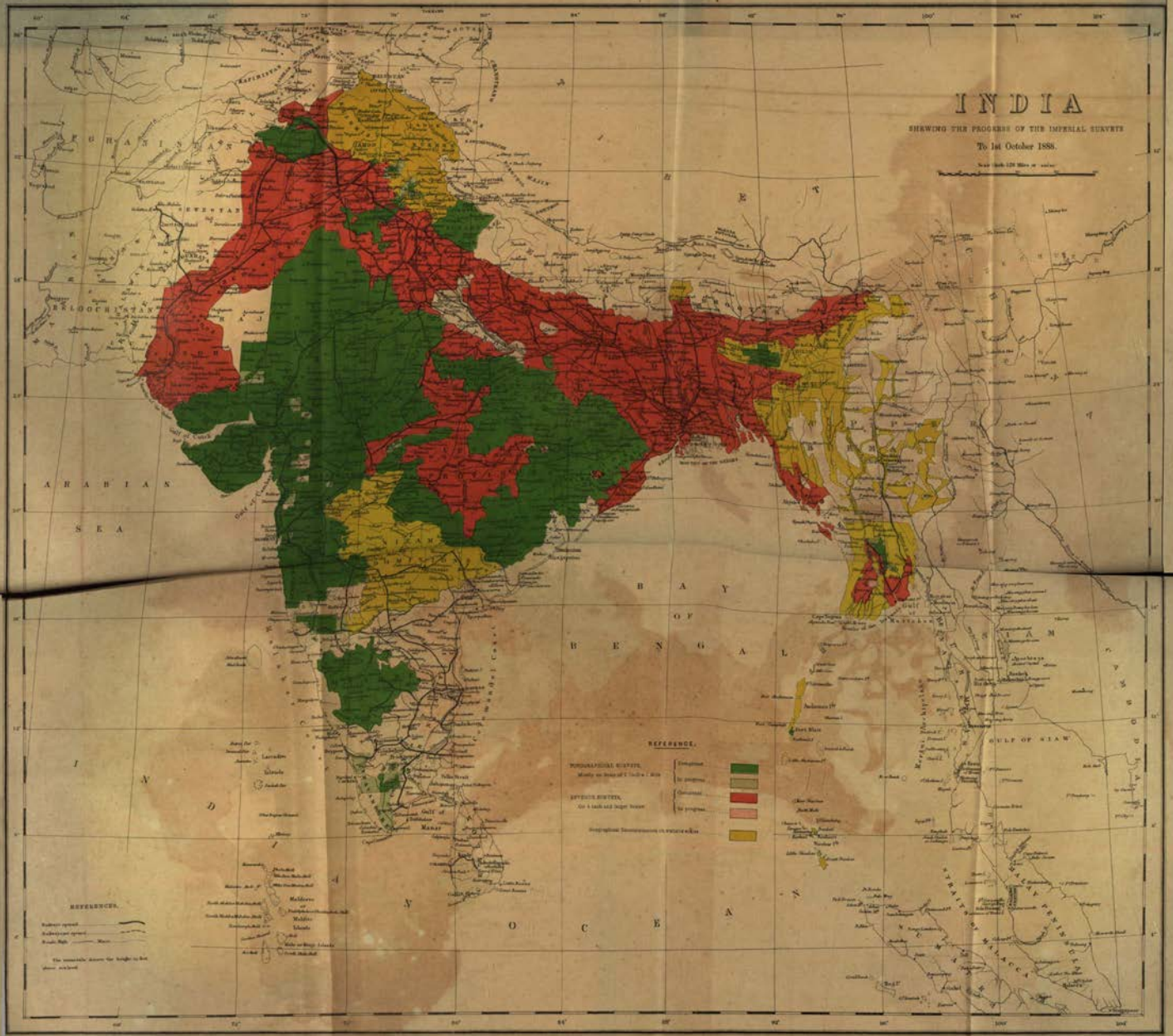

Published under the direction of Colonel H. R. Thuillier, R.E., Surveyor General of India,
March 1889.

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TO THE
GREAT TRIGONOMETRICAL SURVEY
OF
INDIA
SHOWING COLONEL LAMBTON'S NET WORK OF TRIANGULATION IN SOUTHERN INDIA,
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GENERAL REPORT

ON THE

Operations of the Survey of India.

DURING THE SURVEY YEAR

1887-88.

PART I.

INTRODUCTORY.

The period to which this report refers is the year ending 30th September 1888. The administration of the Department and the direct charge of the Topographical Branch have remained in the hands of Colonel H. R. Thuillier, R.E. The Revenue and Trigonometrical Branches continued to be superintended, respectively, by Colonel J. Sconce, S. C., and Colonel C. T. Haig, R.E. The superintendence of the Cartographic and other offices at head-quarters has been carried out by the three Assistant Surveyor-Generals, Colonel D. Macdonald, S.C., Major C. Strahan, R.E., and Lieutenant-Colonel J. Waterhouse, S.C.

2. The various field operations during the year were prosecuted by 26 survey parties and 3 detachments, and are shown collectively in the following tabular statement, grouped with reference to their nature and scope:—

Statement of Survey Operations and Parties.

Number of Parties.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
	Trigonometrical Survey.				
24	Coromandel Coast, Madras.	11	Mr. E. C. Ryall . .	.....	D. S. G. Trig.
	Topographical Surveys.				
10	Southern Maratha Country.	11	Lieutenant-Colonel H. S. Hutchinson, S.C.	2″=1 mile for reduction to half scale, and 8″=1 mile, forest survey for reproduction.	Ditto Rev.
15	Baluchistan . . .	14	Captain F. B. Longe, R.E. .	½″=1 mile for reproduction.	Ditto Topo.
16	Ditto . . .	16	Captain R. A. Wahab, R.E.	½″=1 mile for reproduction.	Ditto ditto.
17	Gujarat, Nasik, and Thana.	18	Colonel A. Pullan, S.C. .	2″=1 mile for reduction to half scale, and 8″=1 mile forest survey, for reproduction.	Ditto ditto.
18	Himalayas . . .	20	Colonel H. C. B. Tanner, Bo. S.C.	4″=1 mile for reproduction and reduction to half scale, and 2″=1 mile for reproduction.	Ditto Trig.
19	Madura, Travancore, and Cochin.	22	Colonel W. F. Badgley, S.C. Major J. R. McCullagh, R.E.	1″=1 mile and 4″=1 mile for reproduction.	Ditto Topo.

Statement of Survey Operations and Parties—continued.

Number of Parties.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
	Forest Surveys.				
14	Hoshangabad	23	Mr. W. H. Patterson Mr. L. J. Pocock	4″=1 mile for reproduction.	D. S. G. Trig.
20	Lower Burma	25	Major Hon'ble M. G. Talbot, R.E. Captain H. M. Jackson, R.E. Mr. M. J. Ogle	4″=1 mile and 2″=1 mile for reproduction.	Ditto Topo.
	Cadastral Surveys.				
2	Bilaspur	27	Lieutenant-Colonel E. H. Steel, S.C.	16″=1 mile for reproduction.	Ditto Rev.
4	Basti and Mirzapur	29	Lieutenant-Colonel S. H. Cowan, S.C.	Ditto ditto and 2″ = 1 mile for reproduction and reduction to half scale.	Ditto ditto.
4*a*	Srinagar Ward's Estate	33	Mr. G. B. Scott	16″ = 1 mile for reproduction.	Ditto ditto.
5	Gorakhpur and Tarai	36	Lieutenant-Colonel J. E. Sandeman, S.C.	Ditto ditto	Ditto ditto.
6	Nowgong and Sibsagar	42	Mr. E. C. Barrett	Ditto ditto	Ditto ditto.
	Bassein and Thongwa	44	Mr. F. W. Kelly	Ditto ditto	Ditto ditto.
8	Bengal and Orissa	46	Lieutenant-Colonel W. Barron, S.C.	16″=1 mile and 2″=1 mile and 50 feet = 1 inch for reproduction.	Ditto ditto.
	Traverse Surveys.				
1	Punjab	52	Colonel F. Coddington, S.C.	2″=1 mile, compilation for reduction to half scale.	Ditto ditto.
3	Nagpur and Wardha	54	Colonel W. H. Wilkins, S.C.	16″ = 1 mile (skeleton plots).	Ditto ditto.
9	Jubbulpore and Seoni	55	Mr. G. H. Cooke	Ditto ditto	Ditto ditto.
11	Seoni and Chhindwara	56	Lieutenant-Colonel D. C. Andrew, S.C. Mr. W. H. Patterson	Ditto ditto	Ditto ditto.
12	Saugor and Narsinghpur	58	Mr. E. J. Jackson	Ditto ditto	Ditto ditto.
13	Hoshangabad and Betul	59	Mr. A. D'Souza	Ditto ditto	Ditto ditto.
	Geodetic.				
22	Southern India	60	Lieutenant-Colonel W. J. Heaviside, R.E.	.....	Ditto Trig.
23	Ditto	*ib.*	Lieutenant-Colonel G. Strahan, R.E.	.....	Ditto ditto.
	Tidal and Levelling Operations.				
25	India	64	Major J. Hill, R.E. Major M. W. Rogers, R.E.	.....	Ditto ditto.
	Geographical Surveys.				
21	Upper Burma	66	Major J. R. Hobday, S.C.	½″=1 mile	Ditto Topo.
Det.	Hukong Valley	70	Mr. M. J. Ogle	Ditto	Ditto ditto.
Do.	Black Mountain	71	Captain R. A. Wahab, R.E.	½″=1 mile	Ditto ditto.
Do.	Nepal	72	R. N.	.....	Ditto Trig.

Detailed accounts of these operations are given in Part II of this report, in the order in which they appear above and the following is a summary thereof.

TRIGONOMETRICAL SURVEYS.

3. The secondary triangulation along the Madras Coast, which has been in progress for the past six years, has been continued by one small party. The object of these coast line operations is to complete the triangulation of those parts of the coasts of India and Burma where the principal triangulation has not been carried, so that points may be available throughout their lengths for the Marine Survey Department to base their operations on. The triangulation

by the above party has been extended 370 miles in length in continuation of the previous season's operations along the Coromandel Coast as far as Point Calimere in the Tanjore district, and this completes the project for the East Coast of India.

4. It has been found necessary also to extend trigonometrical operations into Baluchistan to secure a reliable basis for the surveys that are being carried out in that country. Secondary triangulation has therefore been undertaken by the staff of the topographical parties, Nos. 15 and 16, engaged in Baluchistan, and it comprises two chains of triangles emanating from the great Indus Series, one along the parallel of 30° N. latitude, and the other approximately up the meridian of 67° E. longitude, both to meet at Quetta. The portions of these series which were completed are of an aggregate length of 270 miles, furnishing 23 new stations.

TOPOGRAPHICAL SURVEYS.

5. The number of field parties employed on regular topographical operations has again been further reduced during the year under report. During the preceding year eight parties had been engaged on this class of work; of these, No. 14, the party which had been employed in the Mirzapur district, North-Western Provinces, was withdrawn therefrom and transferred to the Central Provinces to undertake forest surveys, and No. 21 Party, which had completed the survey of the Nicobar Islands, was moved to Upper Burma for geographical surveys, absorbing the detachment previously employed there. Thus, the number of regular parties engaged on purely topographical work was limited to six, and in two of these half their establishments only were employed in this class of work. These six parties were employed in the same provinces as in the previous year, and in continuation of the work of that year, *viz.* two in the Bombay Presidency, two in Baluchistan, one in the Madras Presidency, and the sixth in the Himalayas.

6. The two parties in the Bombay Presidency were organized under the same system as before, whereby one-half of each party was employed in topographical surveys and the other half on forest surveys in the northern and southern Forest Circles respectively; of the topographical sections one has been employed in the Belgaum and Dharwar districts, and the other in Gujarat. The system of dividing each party for two classes of work has since been changed at the instance of the Bombay Government, and in future there will be one entire party for topographical surveys and another exclusively for forest surveys in that Presidency.

7. The parties in Baluchistan have continued the military surveys in that country on the $\frac{1}{2}$-inch scale. In the Madras Presidency the topographical operations were carried on in the Madura district and in the Native States of Travancore and Cochin. The party in the Himalayas has continued its operations in the Kángra district and in the Hill States about Simla. In addition to topographical work, this party also carries on skeleton traverse work in the British districts for the Settlement Department of the Punjab, by which the tri-junctions of village and other internal boundaries are fixed, in order to provide a framework for the Settlement Surveys to be executed by district establishments.

8. In addition to the six parties above referred to, a topographical section was attached to one of the cadastral parties employed in the North-Western Provinces to undertake the survey of the area in the Mirzapur district which had been left by No. 14 Party in the previous season. This has been completed and the survey of the entire district is now finished.

9. In the plains of the Punjab little original work has been done this year, but the traverse party employed there has compiled new topographical maps, embracing a large area on a freshly executed traverse basis, for which the topography is obtained by reduction from the existing village maps of Settlement Surveys of revenue-paying districts, the topography, however, being tested in the field after reduction. During the year these reductions have been carried out mainly for districts Ferozepore and Umballa and for the Faridkot State, in which areas settlement maps were found to be available. To complete the new series of standard maps for the entire province, the existing topography of the

Sikh States, according to the surveys on the one-inch scale of 1847-50, is being utilized, likewise on a fresh traverse basis, with such additions as are available from the recent canal surveys of the Irrigation Department.

10. The aggregate out-turn of the topographical parties on various scales amounts to 15,673 square miles against 17,510 square miles in 1886-87, when two more parties were employed, and it is composed as follows:—

11,977	square miles	surveyed	on the	½-inch scale.
1,276	„	„	„	1-inch „
1,739	„	„	„	2-inch „
557	„	„	„	4-inch „
124	„	„	„	6-inch „

These results are exclusive of the standard mapping in the plains of the Punjab, described in the preceding paragraph.

FOREST SURVEYS.

11. Two half-parties were employed, as in the previous year, on forest surveys in the northern and southern circles of the Bombay Presidency. Under instructions from the Government of Bombay, the character of the forest maps in the Southern Circle has been changed, and, instead of a special kind of skeleton map, showing boundaries, main streams and roads, which had been adopted in this circle for two seasons, a complete survey has been made, giving all the topographical details obtainable on the 8-inch scale, and similar to the survey which had been done in the Northern Circle during the previous season, and which was again continued this year. By the extension of the operations in the latter circle over different parts of the country, great advantage has been gained, as by this arrangement unhealthy tracts could be dealt with at the most favourable time of the year only, and establishments employed elsewhere during the unhealthy period: a large out-turn was thus obtained at a very moderate cost. The half sections of two survey parties, which have been employed hitherto in the northern and southern circles, have since been combined to form one extra survey party to work directly under the Bombay Government, and the scale for the forest survey maps will in future be 4 inches to the mile, instead of the 8-inch scale which has been hitherto demanded.

12. In the Central Provinces one party has been engaged on forest surveys in the Hoshangabad district. These operations were initiated there this year, and owing to this being the first season, and to the very unfavourable climatic and local conditions met with, the out-turn of final survey has been small.

13. The party in Lower Burma has continued the survey of the forest reserves in the Prome and Tharrawaddy districts. The difficulties met with in the previous year from the unsettled state of the country had fortunately disappeared, and the operations were carried on unremittingly, resulting in a satisfactory out-turn. The physical difficulties of the country surveyed were, however, as great as before; the reserves in the Pegu Yoma being especially formidable.

14. In the North-West Provinces, the Gorakhpur forests, which occupy level tracts surrounded by village lands, have been surveyed by the party engaged on the cadastral survey of that district, on the scale of 8 inches to the mile.

15. In Bengal, in conjunction with the cadastral survey of the Government Estate of Angul in Orissa, a commencement has been made of the survey of the reserved forests there, which cover a considerable extent of hilly country; the scale of survey for the forests having been specially fixed by the Government of Bengal at 2 inches to the mile.

16. The forest areas that have been surveyed in the different operations referred to are as follows:—

354	square miles	surveyed	on the	4-inch scale.
539	„	„	„	8-inch „

CADASTRAL SURVEYS.

17. The six parties, which were engaged on cadastral surveys during the previous season, have been employed on the continuation of the same operations

as before, along with certain new surveys in the case of two of the parties, and a seventh party has been added specially for the survey of a Ward's Estate in Bengal. (1) The party working in the Central Provinces has been employed entirely in the Bilaspur district, the diversion of one section to the Raipur district during the previous season, which had been ordered on account of the partial failure of crops in Bilaspur, having been temporary only, and no further cadastral work being required from the party in the Raipur district. As many of the *patwáris* of the Bilaspur district as could be spared from settlement duties have been employed as cadastral surveyors, but the greater part of the work has been done by professional *amins* from the North-West Provinces. The operations have included the preparation of all the village papers required for settlement purposes. (2) The area remaining in the Basti district of the North-West Provinces has furnished employment for one section of the party hitherto employed there, and the survey of the district after five seasons' work, which has included the preparation of complete sets of village papers constituting the Record of Rights, is now finished. In connection with the survey of this district the minute sub-division of the land may again be mentioned, the average size of the plots being 0·32 of an acre, or about the same as last year, while over the whole district the average is found to be 0·34 of an acre, giving 1,868 plots to the square mile. The second section of this party, there being insufficient area in Basti, has been employed on the cadastral survey of certain portions of the family domains of the Maharajah of Benares in the Mirzapur district, asked for by the Maharajah to be undertaken at his expense. This section has also undertaken the cadastral survey of the permanently cultivated lands in *pargana* Dudhi, a Government Estate in the south of the Mirzapur district, for which special arrangements had been made at the time the *pargana* was surveyed topographically three years previously. The third section of the party, for which there was no work in the North-West Provinces, was transferred to Bengal, where it formed the nucleus of a new cadastral party for the survey of the Srinagar Ward's Estate; and the whole party, being no longer required in the North-West Provinces, has since been transferred to Bengal. (3) The Gorakhpur party has again worked with a specially increased establishment, so as to finish the large area remaining in the district in one season, as required by the conditions of the expiring settlement; and the survey of Gorakhpur, which has occupied this party for five seasons, has now been completed. As part of the operations of the cadastral survey, the preparation of all the village papers constituting the Record of Rights has been undertaken by the party throughout the district. A detachment of the party has again been sent to the Tarai district for the cadastral survey of certain selected tracts; and the system begun during the previous season of employing the village *patwáris* as cadastral surveyors has been continued with excellent results. In preparation for next season, the traversing section of the party has carried on advance work in the Jhansi district, where a cadastral survey is about to be undertaken through the agency of the village *patwáris*. (4) The party working in Assam has completed during the present season the entire area required to be surveyed in Nowgong, which is the third district in which cadastral operations have been undertaken, and the survey, as usual, has been restricted to the tracts where the cultivation is permanent. A considerable part of the cadastral survey of the season has been done by the *mandals* (village head-men), who have been found to be quite efficient surveyors under careful supervision. The next district for survey is Sibsagar, where preliminary traversing of boundaries has been carried on, and where some of the *mandals* have been trained. (5) In Burma, the area assigned for survey in the Bassein district has been finished, but the greater part of the work has been in the Thongwa district, where a considerable area still remains to be surveyed. A scheme for the permanent employment of Burmans as cadastral surveyors in place of Hindustanis, who have hitherto formed the main strength of the native establishment, has been partially successful. (6) In Bengal, the party which had been organized during the previous season for the survey of the Town of Calcutta, and other detached surveys, has again been distributed in sections, in different parts of the province, carrying on the same operations, with the addition of the survey of another Government Estate in Orissa and another Ward's Estate in Eastern Bengal. (*a*) The Calcutta Town Survey will be referred to in the proper place hereafter. (*b*) The second section has con-

tinued the survey of the Sankarpur Ward's Estate, which is mostly composed of villages or groups of villages situated in different parts of the Dinagepore district, but with other villages, lying generally singly, in the adjoining districts of Purneah, Rajshaye and Bogra. The detached character of the villages, the positions of some of which were hardly known to the Estate officials, has again rendered the survey very tedious, and a few villages still remain to be surveyed. Simultaneously with Sankarpur, this section has undertaken as a new operation the cadastral survey of the Maldwar Ward's Estate, which is of similar character to Sankarpur, and is composed of villages detached either singly or in small groups in different parts of districts Dinagepore and Purneah. A few out-lying villages of this Estate also remain to be surveyed. (*c*) The third section has continued its operations of the previous season in the Government estate of Angul in Orissa. The *sarbarákárs* (village head-men), who had been previously trained, have been successfully employed as cadastral surveyors, 286 having been used in that capacity. (*d*) The formation of a fourth section for the survey of another estate necessitated the restriction of the topographical operations in Angul, which have been reported on elsewhere, but the triangulation of the forests has been completed, as well as the traversing of the whole estate. This section began and finished the cadastral survey of Bánki, a Government Estate in the Cuttack district, comprising 118 square miles in area, the survey having been effected through the agency of the Estate *sarbarákárs*, or their nominees. Towards the end of the field season, this section also undertook boundary traversing in the Ward's Estate of Kujang in the Cuttack district, in preparation for a cadastral survey next season.

18. The seventh cadastral party has been newly formed, on the nucleus of the traverse section of the Basti party for the survey of the Raj Banaili and Srinagar Ward's Estate, which is composed of detached village and groups of villages in districts Bhagalpur, Monghyr, Purneah and Maldah. The villages of this estate, though spread over a large area, were readily accessible through good communications, and the survey has been facilitated by a number of experienced *amins* becoming available for other employment during the course of the field season, owing to the completion of the survey of a neighbouring district in the North-West Provinces. Good progress has thus been made and the cadastral survey of the villages in the Bhagalpur and Monghyr districts has been completed, while preparatory boundary traversing has been carried out for the villages in the Purneah district.

19. The areas that have been surveyed cadastrally are:—

	Square miles.
Central Provinces	1,044
North-West Provinces	1,959
Assam	587
Burma	791
Bengal	1,054
TOTAL	5,435

During 1886-87, the aggregate out-turn was 4,273 square miles.

TOWN SURVEY.

20. The field plans of the survey of Calcutta have been nearly completed, except as regards the investigation of the boundaries of properties, which operation involves the summoning on fixed dates of the interested proprietors who are met by a European officer, when the boundaries, as agreed to, are inserted on the plans. Disputed boundaries are being settled by a judicial officer, specially appointed by the Government of Bengal. A beginning has been made in the drawing of the final maps for publication on a series of uniform-sized sheets, but this work proceeds slowly on account of the great mass of details to be transferred from the field plans.

TRAVERSE SURVEYS.

21. The traversing in the plains of the Punjab, which is designed mainly for the construction of topographical maps by reduction from the village maps

of the Settlement Surveys, but which also serves for the testing of the accuracy of the frame-work on which the village maps are plotted, has been continued and completed throughout districts Amritsar and Lahore, the mapping of these districts awaits the completion of the Settlement Surveys. Traversing of a limited kind has also been continued in the Sikh States for the purposes of the compilation of a new series of maps from the materials of former topographical surveys.

22. In the Central Provinces, the traverse surveys, conducted for the purpose of furnishing skeleton plots of villages for field surveys by *patwáris* working under Settlement Officers, have been continued in districts Raipur, Jubbulpore, and Narsinghpur, which districts have been completed, and further progress has been made in districts Saugor, Seoni, and Chhindwara, while operations have been begun in four new districts, *viz.* Nagpur, Wardha, Hoshangabad, and Betul. The design of the traverse surveys in the Central Provinces includes the construction of a complete frame-work for the plotting of the fields throughout the village areas, besides the traverses placed along the village boundaries.

23. The areas which have been traversed are :—

	Square miles.
Punjab	5,795
Central Provinces	14,287
TOTAL	20,082

The out-turn in the previous year of this class of work was 16,661 square miles.

SPECIAL OPERATIONS.

24. The Telegraphic Longitude operations, which had been suspended owing to the paucity of officers, were resumed in the season under report. Seven arcs of longitude were measured between trigonometrical stations in Southern India, which are particularly interesting in a geodetic point of view as furnishing corroborative evidence on the existence of an excess of gravitation towards the ocean surrounding India.

25. The Tidal operations have been continued as usual; observations with the self-registering tide gauges were taken at 18 stations in India, Burma, Ceylon, Aden, and the Andaman Islands. Two observatories, Negapatam and Elephant Point, were dismantled, and two new ones, Tuticorin and Prince's Dock, Bombay, have been established.

In connection with these operations, spirit levelling operations were carried out from Madras to Vizagapatam, *vid* Nellore, Guntur, and Coconada, and from Chinsurah to Nuddea, along the right bank of the Hooghly river.

GEOGRAPHICAL SURVEYS AND EXPLORATIONS.

26. The party which has been employed under Major Hobday on the reconnaissance survey of Upper Burma since the occupation of the country, and which now constitutes No. 21 Party, has done a very large amount of useful work during the past field season, chiefly in connection with the various military expeditions undertaken for the pacification of the country. The expedition to the Southern Shan States was accompanied by Captain Jackson, R.E., who carried on a survey from Fort Stedman down the valley of the Balu Chaung to Pèkôn, whence he advanced across the Pon and Tein rivers to Maukmè and the Salween river, and thence northwards to Thibaw. He succeeded in mapping, more or less completely, about 4,500 square miles of country on the $\frac{1}{4}$ inch scale. In the Northern Shan States an area of about 3,500 square miles was surveyed on the same scale by the sub-surveyor who accompanied the column which proceeded thither, and valuable reconnaissances were also made by the military officers with the column. Materials have thus been obtained for a valuable map of the Cis-Salween Shan States. Surveyors were also detailed to accompany the columns proceeding into the Yaw country and Mogaung, and a considerable extent of country has been surveyed in these directions. A large scale survey of the Ruby Mine tract has also been made. As the result of the year's operations in Upper Burma, triangulation has been extended over an area of

23,000 square miles, and nearly 21,000 square miles of country have been surveyed and mapped on the ¼-inch scale.

27. The expedition under Mr. J. F. Needham to explore the routes leading from Upper Assam to the Hukong Valley in Upper Burma was accompanied by Mr. M. J. Ogle, Surveyor, who completed the survey of 1,500 square miles of unknown country lying to the south of the Patkoi range, which he connected with work done previously by Colonel Woodthorpe to the east. This acquisition of new geography compensates in some measure for the failure of the expedition in reaching its objective point; at the same time it has been so far successful as to establish the practicability of direct communication from Assam to Burma over the Patkoi pass by either of the two routes explored.

28. Captain Wahab, R.E., with a small survey party, accompanied the military expedition to the Black Mountain country, and although this did not occur till after the period of this report, the results being available before the report is published, the opportunity is taken to incorporate them. An area of 423 square miles, including a considerable tract across the Indus, adjoining Buner, and of the Indus valley above Thakot, was surveyed and mapped. The course of the river was laid down to some distance north of Thakot, with the exception of some 13 miles between Judbai and the mouth of the Chakeswar river, which the survey party had not the opportunity of reconnoitring. This survey forms a valuable acquisition to our geographical knowledge of the Hazara border.

29. An assistant surveyor, Yusuf Sharif, K.B., was deputed in October 1887 to join the Afghan Boundary Rectification Commission, under Colonel Yate, C.S.I., and he accompanied the military escort which was sent from India for the same object. On the completion of his duties therewith in February 1888, he was directed, with the permission of the Amir of Afghanistan, to avail himself of the opportunity of his return journey to India to survey certain routes. He succeeded in surveying about 4,600 square miles of new country, which is a most valuable addition to our knowledge of Afghanistan. The account of his journey has been separately printed. In recognition of his services on this occasion the Government of India have awarded Yusuf Sharif a *khilat* of ₹3,000.

30. The aggregate areas that have been geographically surveyed in the operations above described are—

26,800 square miles on the ¼-inch scale.
423 " " ½ " "

31. Exploration work on the northern frontier of India was confined to a rough triangulation and reconnaissance of Western Nepal from the Kumaun boundary to the Gandak river. No attempt was made to penetrate the Nepal country, but the work was done chiefly by distant sketching, and by fixing some of its more prominent peaks and ridges by observations taken at the Tower stations of the North-East Longitudinal survey of the G. T. Series, thus furnishing materials for a rough sketch map. A sketch of this kind has now been secured along the whole boundary of Nepal from Kumaun to Sikkim, admittedly imperfect, but valuable as a first step towards the mapping of this hitherto unknown region.

32. A complete report of the itineraries and narratives of R. N., K. P., Lama U. G., and the Mongolian Lama (referred to in paras 21, 22, and 311 of the last Administration Report), embodying a large amount of information regarding Bhutan and Tibet is now in the press, and will shortly be ready.

HEAD-QUARTERS OFFICES.

33. The details of the mapping and other scientific work done in the head-quarters offices at Calcutta and Dehra are given in Part III of this report.

34. The number of entirely new maps that have been published during the year amounted to 4,062, of which 3,866 were cadastral maps. The total number of maps issued amounted to 185,656, which are valued at ₹1,11,793. The income from map sales amounted to ₹10,381.

35. In the Drawing Offices, the pressure of work has continued unabated, due to the vast amount of mapping which has been entailed in connection with the surveys of the Afghan Boundary Commission, and the necessity of preparing new editions of the ¼-inch reconnaissance sheets of Upper Burma, as well as general maps thereof. The preparation of the new trans-frontier maps and those

of Burma have employed the majority of the staff of the drawing sections during the year, somewhat to the detriment of the progress of the ordinary current work. In connection with the former a general map of Afghanistan, embodying all recent surveys, has been compiled on the scale of 24 miles to the inch, and is now ready, but its publication has been deferred, pending instructions from the Government. Two new compilations of Burma are under preparation and are making good progress, *viz.* (1) Burma and adjoining countries, on the 32-mile scale, (2) Upper Burma, on the 16-mile scale. Of other compilations that have been completed, the most important are those of the work of explorers in Bhutan, Tibet, and the Lower Sangpo, and of the route taken by Lieutenant F. E. Younghusband from Pekin to Kashmir.

36. Arrangements have been made with the Government of the North-West Provinces for the transfer to this department of the mapping work which has hitherto been prepared in the office of the Board of Revenue at Allahabad, where a drawing establishment has been maintained. The preparation of district maps of the North-West Provinces on the $\frac{1}{2}$-inch scale has consequently been commenced and will be carried to a conclusion in this department.

37. In the Photographic and Lithographic Offices the out-turn is again very large, the total number of copies of maps and other subjects of all kinds printed in the two offices being 1,203,861, and their value ₹1,84,595.

38. In the Lithographic Office progress has been made with the preparation of the new edition of the 32-mile map of India. It has been delayed on account of changes necessitated by the receipt of new material from Burma and other parts, but it is hoped that it will be published in the course of a few months. The Canal Map of India on the same scale has been reprinted with several additions. A large amount of work has been done for other departments. The new Military and Railway Map has been nearly completed, as originally designed, but, owing to recent changes in the military commands and acquisitions of territory east and west, it will require considerable alteration and addition before it can be published. Three more of the series of crop-maps have been printed off, *viz.* Sugar-cane, Wheat, and Indigo. Maps illustrating the gauges and systems of railways in India have also been lithographed for the Railway Department, and large numbers of weather charts and meteorological diagrams, geological maps, and sketches, archæological plates, &c., have been produced for the departments concerned.

39. The bulk of the departmental maps are photozincographed, and among the publications of the year may be noted a new outline map of India, showing railways, prepared for the Secretary of State for India on two different scales, 48 and 64 miles to the inch, and a plan of Mandalay on the scale of 6″ = 1 mile in 4 sheets.

40. The heliogravure process of photo-etching has made good progress and has been largely used for the preparation of the plates illustrating Dr. Burgess' Archæological Report on Jaunpur. The demands now coming in for work to be done in this manner already exceed the capabilities of the office for printing them off and are likely to increase. The view of the Survey of India Offices, Calcutta, now completed, which forms the frontispiece of this Report, and that of the new Mathematical Instrument Office, at page 92, show the perfection to which the process has now arrived. Photocollotype has been to some extent put aside in favour of heliogravure, which has many advantages. Blue printing processes have received attention during the year: they form valuable and inexpensive means of reproducing maps and drawings in small numbers.

41. The demands on the Mathematical Instrument Office for survey and scientific instruments continue to increase. The number issued on indent during the year under review amounted to 57,293, valued at ₹2,25,599, the issue during the previous year having been 37,391 instruments, valued at ₹1,83,519. The principal causes of these increasing demands are due to the annexation of Upper Burma, and the consequent construction of public works there, as well as to the extension of railways in India. During the same period 66,299 serviceable instruments, valued at ₹2,65,487, and 3,794 repairable instruments, valued at ₹44,313, were received into store.

42. In the Trigonometrical Branch Office, the Computing section has made considerable progress with the final reductions of the principal triangulation of

India, of which the results of two large sections, the south-west quadrilateral and the southern trigon remain to be published.

ESTABLISHMENT.

43. The remarks made in paragraph 27 of the last Annual Report regarding the difficulty of providing officers to superintend the various field operations and to meet all the demands made upon the department apply with equal force for the year now under report. It has been found necessary in some cases to place the charge of field parties in the hands of officers of the subordinate or junior division, who, though they may be capable of so serving for a temporary purpose, are not qualified to superintend responsible operations permanently. In view of the large number of prospective retirements in the senior division during the next two years, it is all the more necessary that the recruitment of the establishment should be no longer restricted or retarded. At present three vacancies exist, and eight more retirements are expected to take place during 1889 and 1890. Thus, there is considerable danger that a sufficiency of trained officers will not be available to meet all the demands that may be made on the department, for there is no reserve to fall back upon and no provision has been made to meet this emergency. The calls on the department in all the branches of its work have a tendency to increase rather than to decrease; the probable expansion of the cadastral surveys in Bengal, the increase of military surveys, and the enormous field that has been opened out in Upper Burma for operations of all kinds demand serious consideration, as to whether the present sanctioned strength of officers will suffice. The Government purpose to draw up a fixed programme of work for the next five years, which it is hoped may be the means of arriving at a solution of the difficulty under which the department has been working with inadequate establishments for the past five years.

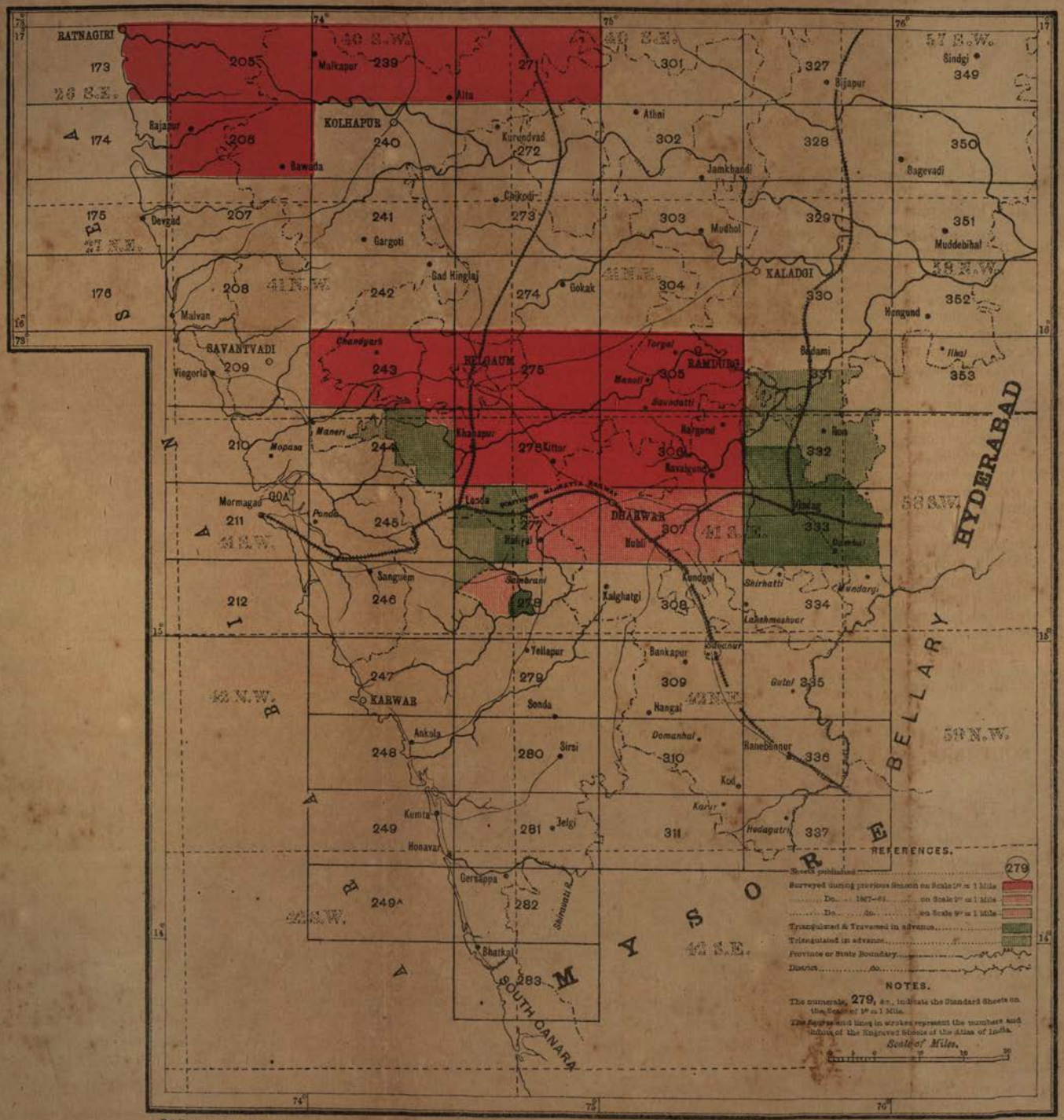
44. During the year, two officers of the senior division have retired from the department,—(1) Lieut.-Colonel W. J. Heaviside, R.E., Deputy Superintendent, 2nd grade, after a service of twenty-two years therein, during which he was chiefly employed in charge of geodetic operations, and among them may be noted the completion and extension of the series of pendulum observations which had been carried on by the late Captain J. P. Basevi, R.E. Colonel Heaviside also served in the Bhutan Campaign of 1865-66 and in the Afghan War of 1878-79, when he was employed on special survey duty with the Southern Afghanistan Field Force, and obtained the brevet of major. (2) Major the Hon'ble M. G. Talbot, R.E., Deputy Superintendent, 4th grade, resigned his appointment and reverted to military duty on 10th April 1888, after a service of 8 years in the Topographical Branch, most of which was passed on the North-Western Frontier, where he has contributed largely to the military surveys of Afghanistan and Baluchistan, in connection with the Afghan Campaigns of 1878-80 and the Russo-Afghan Boundary Commission of 1884-86; for his services in the latter he obtained a brevet majority.

45. In the junior division, three surveyors and assistant surveyors have left the department, two by death and one by retirement; during the same period four new appointments have been made, leaving seven vacancies unfilled.

BOMBAY SURVEY.

INDEX TO THE SOUTH MARATHA TOPOGRAPHICAL SURVEY

No. 10 PARTY.



Reg. No. 266, S. I. O.—23-3-80.—350.

Photo., S. I. O., Calcutta.

PART II.

THE OPERATIONS OF THE SEVERAL FIELD PARTIES.

TRIGONOMETRICAL SURVEYS.

SECONDARY TRIANGULATION.

COROMANDEL COAST, MADRAS.

No. 24 Party.

46. The operations of this party were directed during the past season by Mr. Ryall, their object being, as heretofore, the fixing of various points of reference at intervals of from 5 to 15 miles for the purposes of the survey of the east coast of India by the Marine Survey Department. Hills, conspicuous temples, light-houses, and other permanent marks are pressed into the service, while wooden and masonry beacons are erected at conspicuous spots, especially for this purpose.

Personnel.

Mr. E. C. Ryall, Officiating Deputy Superintendent, 4th grade, in charge.

Mr. J. Bond, Surveyor, 4th grade, up to 1st August 1888.

47. The triangulation was extended during the season under review over six sections, aggregating 370 miles in length, and embracing an area of about 2,100 square miles, by which the positions of 32 marks and beacons were determined. The coast triangulation is now completed from False Point to Point Calimere in the Tanjore district. From Negapatam southwards, for a distance of nearly 60 miles, the stations of the Negapatam Minor Series, on which Mr. Ryall had hoped to base his work, were found to be inconveniently situated, and so hemmed in by gardens and trees that the expense of triangulation was deemed too great to admit of the beacons being fixed by this method. A traverse emanating from Nirdhana Mangalam and closing on Patukota, stations of the Great Trigonometrical Survey, was therefore determined on and executed with the care that is necessary in so extended a traverse as this which is nearly 60 miles in length. Its closing error, which is 22 feet only, has been distributed evenly throughout the whole length in the final computations, and testifies to the accuracy with which the angular and linear measurements have been made. A description of the beacons erected by Mr. Ryall will be found in the extract from his narrative report in the appendix.

48. The field season extended from 6th of November to 21st August, and the health of the various members was satisfactory throughout.*

TOPOGRAPHICAL SURVEYS.

SOUTHERN MARATHA COUNTRY, BOMBAY PRESIDENCY.

No. 10 Party.

49. This party, of which Lieutenant-Colonel H. S. Hutchinson received charge on 22nd October 1887, has again been employed on two distinct operations, one being a topographical survey on the 2-inch scale in continuation of previous work of the same nature, and the other being a forest survey on the 8-inch scale, with full details, in which respect a change has been made from what was executed for the Forest Department last year when the survey was one of boundaries only.

Both sections into which the party was sub-divided for the respective operations left Poona for the Southern Maratha country on 15th November 1887, and returned to Poona for recess on 5th June 1888.

Personnel.

Lieutenant-Colonel H. S. Hutchinson, Officiating Deputy Superintendent, 3rd grade, in charge from 22nd October 1887.

Mr. A. M. Lawson, Surveyor, 2nd grade, in temporary charge up to 21st October 1887.

„ C. Tapsell, Surveyor, 4th grade, from 1st March 1888.

„ W. M. Kelly, Assistant Surveyor, 1st grade.

„ R. R. Dickinson, Assistant Surveyor, 1st grade.

„ O. D. Smart, Assistant Surveyor, 2nd grade, up to 21st February 1888.

29 Sub-surveyors, and others.

* Mr. Ryall speaks favourably of the services of his assistant, Mr. Bond.

50. The country where the topographical survey on the 2-inch scale has been conducted is generally open, and presented few difficulties, although in some parts the details are intricate. Here the health of the establishments was also good. With these advantages, a large out-turn might have been accomplished if half the strength of the party had been kept throughout the season on this branch of the work, but on account of the great difficulties which were met with in the forest tract (about which particulars will afterwards be given) it was found necessary to strengthen the forest section to the detriment of the topographical section, and the topographical area is consequently less than had been expected.

The areas surveyed on the 2-inch scale in the several districts and States are the following:—

	Square miles.
Belgaum district	92
Dharwar „	665
Kaladgi „	25
Kanara „	106
Sangli State	18
Jamkhandi State	28
TOTAL	934

Besides the topographical survey, 1,135 square miles of country have been triangulated and 460 square miles have been traversed in preparation for topographical survey next season. The topography has been tested by 205 linear miles of check surveys.

51. During the recess, the four final sections on the 2-inch scale of sheet 307 have been drawn ready for reduction and printing on the 1-inch scale. Of sheet 277, the two eastern sections to which the topography has extended have been drawn. The drawing has also been completed of two sections of sheet 205, the topography of which had been done during the previous season, and all the sections of this sheet are now ready for reduction and printing.

52. The change above referred to in the character of the work, which has been executed for the Forest Department, was sanctioned by the Government of Bombay, in Revenue Department Resolution No. 8399, dated 8th December 1887, on the representation of Colonel Hutchinson that the skeleton boundary maps of the previous season gave very meagre results for the expenditure incurred on them, and that the superiority of complete topographical maps of the forests would justify their additional cost. The 8-inch scale, the same as had been adopted for the skeleton maps, was retained for the forest topography.

53. As is usual, the ground on which the forest survey section should operate was referred for the decision of the Conservator of Forests, Southern Circle, who indicated the tract known as the Gund plateau with adjoining extensions as the ground most urgently calling for survey on account of its being believed to contain the finest teak forest in the Kanara country which was required to be valued and systematically worked. The tract is quite detached from any triangulation or topographical survey that had yet been executed. In character the country is mountainous, being at the same time intersected by ravines which were almost impassable; one ravine in particular dividing the tract into two parts and defying all attempts to cross it except in places far apart which involved much circuitous marching. For chain traversing the country presented many difficulties, the lines having often to be taken by long detours where boundaries ascended precipices of fully 1,000 feet; besides this, heavy line-clearing was required everywhere; and at times the establishment was quite crippled by sickness, which was more than usually prevalent in jungles at all times proverbially unhealthy.

54. In such a precipitous country, chain traversing by itself would have furnished a very inaccurate basis for the 8-inch maps and a minute triangulation emanating from a Trigonometrical Survey ray had first to be undertaken, by which points were fixed in all positions where the chain distances were required to be corrected. In this triangulation the heights of all its points were determined, as is usual, but, besides the determination of the heights of the triangulation points only, an exceptional system has been introduced into this survey of

vertical angles being observed in combination with the horizontal angles of the chain traversing, by means of which the heights of all the traverse stations have likewise been obtained. These traverse station heights, of which there are 3,100, were not utilized in the field as guides to the sketching of the contours, as the computations could not be got ready in time, but they have been adopted for the rendering of the contour drawing of the fair maps in office, and they have enabled this part of the drawing to be effected in a uniform manner which would otherwise not have been possible, considering the difficulty of sketching in a forest-clad country.

55. Before the computations of the triangulation and traversing could be completed and the skeleton sheets got ready for the topographers, a considerable part of the field season had elapsed, and the detail survey being of the same difficult nature as the traversing, the forest section by itself was found to be quite insufficient to accomplish the projected area. Aid had therefore to be given by the transfer of almost the entire staff of the topographical section, by which means and by prolonging the field season throughout May, the topography on the 8-inch scale of 113 square miles of the forests was eventually accomplished, which, however, did not finish the entire area of 220 square miles which had been triangulated and traversed.

56. The topography has been effected on a continuous series of 33 original sheets filled up to margin, but for the final maps the design has been adopted of projecting the maps according to the villages of the Revenue Survey which have been retained as units for forest administration. These village maps, of which there are 23, have been prepared, as usual, in a style suitable for photozincography on the expectation that the Forest Department will require them to be printed.

57. At the request of the Government of Bombay, a change has been made in the system, which has prevailed for three seasons, of employing this party in sections of equal strength, partly on topographical surveys and partly on forest surveys, the same system likewise prevailing in No. 17 Party, in so much that in future one entire party formed out of the forest sections of Nos. 10 and 17 Parties will be employed on forest surveys, while the second party will be employed exclusively on general topography. The proposed change was discussed at Poona on 19th July at a conference, attended by the Secretary to the Government of India, Revenue and Agricultural Department, by the Chief Secretary to the Government of Bombay, by the Surveyor-General, and by officers of the Forest and Survey Departments, and the matters then agreed to, involving No. 17 Party being placed at the disposal of the Government of Bombay for the execution of Forest surveys, were finally laid before the Government of India in the Government of Bombay, Revenue Department, letter No. 5308, dated 7th August 1888, addressed to the Secretary, Government of India, Revenue and Agricultural Department.

58. Consequent on the withdrawal of No. 17 Party from topographical surveys, the area remaining for survey in Gujarat has been assigned to No. 10 Party, which in future will be organized in two sections to work respectively in the northern and southern tracts of the Bombay Presidency, so that the topographical surveys in progress may proceed without interruption. Besides the area in Gujarat, two sheets in Rajputana situated on the north-western border of Gujarat and remaining over from the Gwalior and Central India Topographical Survey have been assigned to No. 10 Party.

59. The recess office of the party was inspected at Poona during July by the Deputy Surveyor-General in charge of the Revenue Branch, who reports that he was well satisfied with the character of the maps that had been executed, and with the manner in which the survey of the extremely difficult country of the Gund plateau had been undertaken by Colonel Hutchinson.*

* Colonel Hutchinson reports on the services of his assistants as follows:—
"Mr. A. M. Lawson has sustained his reputation of being a first-class surveyor both in field and office. The section surveyed by Mr. Tapsell was perhaps the most difficult done this season. Mr. Kelly has worked hard and well. Mr. Dickinson has worked excellently. The following sub-surveyors deserve notice, *viz.*:—Fyzulah Khan, Vittoba Nagoji, and Mukind Dinker."

BALUCHISTAN.

No. 15 Party.

60. This party assembled at the field depôt, Jacobabad, about the 25th October 1887, and the arrangements for guards, &c., having been previously made, the various detachments marched at once *viâ* Gandáva to the field of operations.

Captain F. B. Longe, R.E., Deputy Superintendent, 4th grade, in charge.
Mr. T. E. M. Claudius, Surveyor, 4th grade.
„ E. A. Wainwright, Do. do.
„ W. C. G. Barckley, Asst. Surveyor, 1st grade.
Mr. A. Kitchen, Asst. Surveyor, 1st grade.
Rai Bahadur Hira Sing, Asst. Surveyor, 3rd grade, from 1st March 1888.

Sub-Surveyors.

Ahmad Ali Khan.
Abdul Rasul.
Husain Bukhsh.
Ata Mahommed.
Kadar Sharif.
Sheikh Mohi-ud-din.

The programme of operations comprised the following:—

(*a*) A trigonometrical series of secondary triangles in extension of the Kalát Series, to connect it southwards with the Great Indus Series at Gandpahár and Khárko.

(*b*) The triangulation of sheet 23 N. W.

(*c*) The topographical survey on the $\frac{1}{2}$-inch scale of sheets 22 $\frac{S.E.}{3 \& 4}$ and 23 $\frac{N.E.}{1 \& 2}$, and as much of 23 $\frac{N.E.}{3 \& 4}$ as time would permit.

61. The object of undertaking the trigonometrical operations was to secure a more reliable basis than that which exists for the topography of Baluchistan and for extensions of the survey that may be required in Southern Afghanistan. The minor triangulation has been based hitherto on the second series that were executed during the Afghan war of 1877-79, *viz.*, one from Shikarpur across the plains up to the Bolan pass and thence to Quetta, and another short series from Quetta southwards to Kalát. This old triangulation was done with inferior instruments under considerable difficulties, both atmospheric and political; it was not sufficiently accurate to incorporate with the rigorous triangulation which has been required elsewhere throughout India, and therefore its systematic reduction has not been attempted.

The limits of the Baluchistan survey have not been precisely defined, but should it be confined to the boundaries of Baluchistan only, the area is so large as to demand a rigorous trigonometrical basis, for it may be said to be equivalent to the area comprised within six degrees of latitude and six degrees of longitude, and the provision of this basis could be no longer deferred in view of the rapid extension of the topographical operations over the country by two field parties. It was decided therefore to carry two chains of triangles emanating from the great Indus series, one along the parallel of 36° N. latitude and the other approximately up the meridian of 67° E. longitude, both to meet at Quetta, to be undertaken by the staff of the topographical parties employed in Baluchistan. The longitudinal series has been executed by No. 16 Party, the particulars of which will be found under the operations of that party, and the meridional series connecting Kalát with the great Indus series has been done by No. 15 Party.

62. Mr. Claudius was entrusted with this special triangulation which he successfully completed by the 1st April 1888. It has been arranged in a series of quadrilaterals comprising 19 stations and spanning a direct distance of about 150 miles. Observations were taken thereat with a 14-inch theodolite: the average triangular error of the angles was 1″·7, the mean discrepancy on common sides amounted to 0·038 feet per mile, and the mean difference in the values obtained for the height of each station was one foot. The work required much energy, determination and intelligence owing to the natural difficulties of the country, the want of roads and the difficulty in providing the detached signalling parties with food and carriage. The severity of the climate in the winter involved considerable hardship and exposure, and the results of Mr. Claudius' labours under such trying circumstances reflect much credit on him.

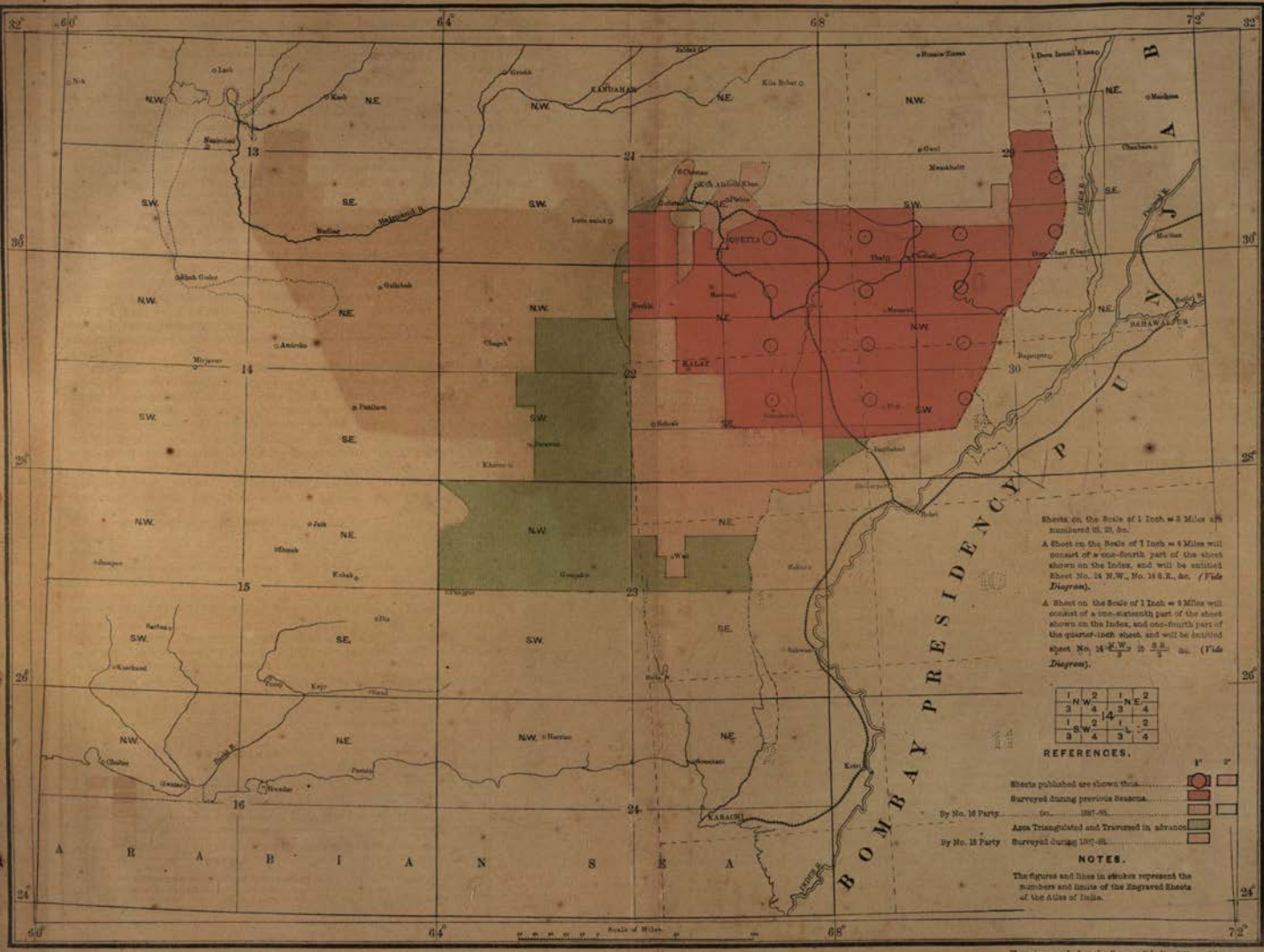
63. The minor triangulation preliminary to detail survey on the $\frac{1}{2}$-inch scale was extended over sheet No. 23 N. W. to supplement and strengthen that which had already been carried out by Major the Hon'ble M. G. Talbot and Captain Wahab in 1884. This was carried out by Mr. Kitchen, and covers an area of 7,300 square miles, all of which is in advance of the detail survey. Observations were taken at 27 stations, and 162 intersected points were fixed.

64. The country surveyed in detail is of a very intricate nature, a small area on the east only being open. The greater portion consisted of very rugged

NORTH WESTERN TRANS-FRONTIER SURVEY.

INDEX TO THE SURVEY OPERATIONS IN BALUCHISTAN.

Nos. 15 & 16 PARTIES.


BOMBAY PRESIDENCY
PUNJAB
ARABIAN SEA
QUETTA
KALAT
KARACHI
KANDAHAR
BAHAWALPUR
Sheets on the Scale of 1 Inch = 8 Miles are numbered 13, 21, &c.
A Sheet on the Scale of 1 Inch = 4 Miles will consist of a one-fourth part of the sheet shown on the Index, and will be entitled Sheet No. 14 N.W., No. 14 S.E., &c. (Vide Diagram).
A Sheet on the Scale of 1 Inch = 2 Miles will consist of a one-sixteenth part of the sheet shown on the Index, and one-fourth part of the quarter-inch sheet, and will be entitled sheet No. 14 N.W. 1 2 3 4 &c. (Vide Diagram).
REFERENCES.
Sheets published are shown thus
Surveyed during previous Seasons
By No. 16 Party ... do. ... 1897-98
Area Triangulated and Traversed in advance
By No. 15 Party Surveyed during 1897-98
NOTES.
The figures and lines in strokes represent the numbers and limits of the Engraved Sheets of the Atlas of India.
Scale of Miles

Published under the direction of Colonel H. R. Thuillier, R. E., *Surveyor General of India.*
Survey of India Office, Calcutta, August,
1898

Photozincographed at the Survey of India Office, Calcutta.

and almost impenetrable hills which necessitated very careful survey and caused the surveyors a great deal of physical exertion. The climate for several months was trying, the days being short and the cold intense during the mornings and evenings. Thus the work progressed slowly for a time, but as the weather improved the out-turn increased, and by the end of the field season early in April 7,564 square miles had been surveyed on the ½-inch scale, a very creditable out-turn, considering the difficult nature of the country surveyed. The work of each plane-tabler was examined by Captain Longe at least once during the field season and was found as a rule to be exceedingly good.

65. In the area surveyed the chief towns or villages are Jhal and Shadihar, in the Kachhi or plain country, on the eastern border, and Suráb, Nál, Khozdár, Zidi, Karu, Bhagwána, Chad, and Gidar in the hills, but these are merely collections of mud huts, scattered here and there, where sufficient water is found to permit of the land being cultivated by irrigation. In these villages or hamlets, the landlords and a few *raiyats* (who carry on the cultivation) reside, the rest of the people being nomadic, migrate to Sind and the Kachhi in the winter and return with their flocks and camels as the weather gets warm; they wander about the hills, and stay for a time in places where they obtain water and grazing for their herds, and even cultivate patches of ground in these spots; but they mostly depend for their subsistence on what they have brought back from the plains, and what they buy from Sindee *banias* who have temporarily settled in the permanent villages. Captain Longe has written an account of the country topographically surveyed during the year, which has been separately printed.

66. The field season closed at Jacobabad towards the end of April and recess office was reopened at Mussooree on the 10th May. A detachment consisting of one assistant surveyor, one sub-surveyor and a few *khalásis* was left at Quetta to carry out the large scale survey of the town and cantonments in conjunction with the detachment left by No. 16 Party, and the particulars of this work will be found under the operations of that party. They were also employed on the computations of the triangulation. At Mussooree the fair mapping of sheets $21\frac{S.E.}{4}$, $22\frac{S.E.}{3\&4}$, and $23\frac{N.E}{1\&2}$ has been completed, and the computations have been brought up as far as was possible. Besides the above, corrections and additions have been made to various maps previously issued in a preliminary form.

67. The three native soldiers who had been attached to this party during the previous year for training in surveying completed their course of instruction during the year under review and were returned to their regiments at the end of the field season. They are reported to have worked most satisfactorily and to have become good topographers. They aided in the general out-turn of the season and were further instructed in reconnaissance surveying in which class of work they have become proficient. Two of them, Lance Duffadars Abdul Jabbar, 11th Bengal Cavalry, and Narain Sing, 5th Bengal Cavalry, are specially brought to notice for their aptitude and efficiency in surveying and for their qualifications in drawing. It is hoped that opportunities will be given to them to keep up the knowledge they have gained.

68. In consequence of the decision of the Government that one party only is to be employed for the present in carrying out the military programme in Baluchistan, the extension of the general survey to the south and west of the present season's operations will be suspended and this party will be employed next season mainly in extending the 2-inch survey in the neighbourhood of Quetta and Pishin in accordance with a requisition from the military authorities and in revising the survey of the country about the Bolan and Harnai routes. The trigonometrical operations between Dera Ghazi Khan and Quetta which have been left incomplete by No. 16 Party will also be carried to a conclusion.*

* Captain Longe reports as follows on his assistants :—" Mr. Claudius has, as in former years, shown himself to be thoroughly reliable, devoted to his work, and ready and willing to take up anything. I consider that no executive officer could have a more valuable assistant. Mr. Wainwright has in every way performed his duties to my entire satisfaction. Mr. Barckley has worked very satisfactorily on the whole, but is not sufficiently exact in carrying out instructions : he has however lots of energy and talent. Mr. Kitchen has never failed in working to my complete satisfaction and has maintained his reputation as a draftsman. When he has gained more experience in triangulation and computing, he will be in every way a very valuable assistant."

The sub-surveyors are generally favourably reported on, and the qualifications and work of Ahmad Ali Khan and Husain Bukhsh are prominently brought to notice.

BALUCHISTAN.

No. 16 Party.

69. This party, under the superintendence of Captain Wahab, R.E., resumed field operations on 1st November 1887, and continued them until 26th April 1888, when the head-quarters returned to recess at Mussooree. The strength of the party is shown in the margin. Lieutenant Mackenzie joined at the end of the field season, and during January and February, Captain Wahab and Sub-Surveyor Abdul Ghafar were detached from the party to accompany a small expedition for exploration in the Gumal Pass. The party was thus rather weaker than usual, and the out-turn during the cold weather months, as compared with that of previous seasons, was small. This had, however, been anticipated in arranging the season's programme which was carried out in its entirety.

Personnel.

Captain R. A. Wahab, R.E., Officiating Deputy Superintendent, 4th grade, in charge.
Lieutenant R. J. H. L. Mackenzie, R.E., Assistant Superintendent, 2nd grade, from 26th March 1888.
Mr. W. W. McNair, Surveyor, 3rd grade
„ E. Graham, Assistant Surveyor, 1st grade.
„ G. P. Tate, „ „ 2nd „
„ B. R. Hughes, „ „ „ „

Sub-Surveyors.

Imam Sharif, K.B., Abdul Ghafar, Ghulam Mahomed, Mahomed Husen, Asghar Ali, Safir Ali, and Imam Bakhsh.

70. A detachment consisting of one European surveyor and one sub-surveyor from this party and the same number from No. 15 Party, under Lieutenant Mackenzie, R.E., was left in Quetta during the recess season for employment in any work that might be urgently required.

71. The field work has included the extension of the general survey of Baluchistan on the scale of ½ an inch to the mile, and a survey of the town and cantonment of Quetta on the 16-inch scale, with a record of all properties, on the cadastral system. Minor triangulation, preparatory to further extension of the ½-inch survey, was carried on towards Kharán and of the 2-inch survey south-west of Quetta. A trigonometrical series of secondary triangles along the parallel of 30° latitude to connect Quetta with the Great Indus series near Dera Ghazi Khan was commenced.

72. The year's out-turn comprises the detail survey of 4,413 square miles on the ½-inch scale, the town survey of 4,300 acres on the 16-inch scale, the minor triangulation of an area of 6,432 square miles, and the trigonometrical series, which was completed over a length of 120 miles, embracing an area of 4,725 square miles.

73. The country topographically surveyed on the ½-inch scale lies south and south-west of Kalát, and is thus described by Captain Wahab: "The general elevation is the highest at which operations have yet been carried on in Baluchistan, including, as it does, the highest part of the Brahui mountain system which forms the water parting between the Indus valley and the valleys and plains of Baluchistan proper. It presents the usual physical characteristics of the Baluchistan highlands, *viz.*, long level valleys, cultivated at the few spots where water is obtainable and overlooked by high rugged ranges, generally bare of vegetation, or occasionally dotted with a few straggling junipers on the highest ridges, or the wild pistachio at a lower elevation. The country is sparsely populated, and in the winter the villages are often entirely deserted, the Brahuis who inhabit them migrating to the warmer climate of the Kachhi, the plain between the hills and the Indus. Supplies are obtainable with the greatest difficulty, and during the season under report almost everything required by the detached parties had to be purchased at Kalát and sent out sometimes to a distance of 50 miles. Heavy snow fell during January, February and March, and work was carried on with so much difficulty that the average out-turn per man for those months fell from over 150 square miles to less than 50."

74. The object of the trigonometrical operations which have been undertaken by this party have been referred to in paragraph 61 of this Report. The triangulation emanated from the stations of Dalura, Dajil and Tobwala of the Great Indus series, and was extended to form a longitudinal series, along the 30th parallel up to Quetta, where it will join the Kalát series. The work was

entrusted to Mr. McNair, who was engaged thereon till the middle of April, when hazy weather set in and prevented the completion of the series. The triangulation was carried up to the neighbourhood of Loralai, a distance of about 120 miles, observations having been completed at 11 stations.

75. The instrument used for this series was a 15¾-inch theodolite by Carey, which was selected as the best of the small micrometer theodolites in stock. A fairly portable instrument was a desideratum, owing to the rugged nature of the hills on which the stations had necessarily to be placed, and in this respect proved very satisfactory. The errors of graduation, however, have been found to be large, the differences in the angles on the different zeros being generally as much as 20 seconds, and though the mean results, as shown by the triangular errors (which average 1·21 second and in no case exceed 3 seconds), are fairly good; the value of the angles as shown by the weights is disappointing.

76. The difficulties that had to be overcome in carrying out this triangulation were by no means slight. The stations were generally long distances apart—and the difficulty of communicating with the signallers, for whose protection and rationing careful arrangements had to be made, was a source of constant anxiety to Mr. McNair. The computations show the care and accuracy with which the observations were made, and the final results compare well with any previously obtained with the same instrument.

77. The requisition for the preparation of a large scale map of the town and cantonment of Quetta, to meet the wants of the civil authorities, was not received until towards the end of the usual field season, and the survey was undertaken during the recess season by the detachment which remained at Quetta. The scale of 16 inches to a mile was adopted for the survey, and it was decided to make at the same time a record, as complete as possible, of all properties situated within the limits of the civil portion of the station. This has proved a somewhat difficult task owing to the constant changes that have occurred, even during the progress of the survey, in the tenancies, and to the number and small size of the blocks in the bazars. The station, too, being a new and rapidly growing one, the demarcation of properties, &c., is very imperfect, and no previous record had been made which would have served as a basis for the present one. The survey was completed during the recess.

78. As previously mentioned, Captain Wahab and a sub-surveyor were detached in January 1888 to accompany an expedition, under the Deputy Commissioner of Dera Ismail Khan, for exploration work in the Gumal Pass. The failure of this expedition has previously been reported to the Government, and little or no additional geography of the country was obtained, as Captain Wahab was unable to ascend any hill overlooking the country beyond Kajuri Kachh (up to which point the pass had been surveyed in 1883-84 by Sub-Surveyor Yusuf Sharif), but he has obtained the heights of a number of points along the pass, and of several hill peaks which will be useful in any future operations. Yusuf Sharif's work was thoroughly tested and found exceedingly good.

79. Two native soldiers were attached to this party and completed their course of training during this season and were returned to their regiments; their work has been very favourably reported on.

80. During the recess the computations of both the principal and minor triangulations have been completed, and triangulation charts of the degree sheets contained in sheet 21 S. E. have been prepared, showing all the triangulation completed up to date. Fair maps of all the season's ½-inch survey have been drawn, and also those of the 16-inch survey of Quetta.

81. In consequence of the orders of the Government that one party only is to be employed on the military surveys in Baluchistan, pending the erection of the quarters which have been sanctioned for the accommodation of the establishment, in view of their permanent location in Baluchistan, this party has now been temporarily disbanded and the members distributed elsewhere.*

* Captain Wahab reports of his assistants as follows:—"The work executed by the European assistants and sub-surveyors was carried out without exception in a most praiseworthy manner in spite of hardships and difficulties. Mr. W. W. McNair, to whom was entrusted the most important part of the season's work, carried out his observations under trying circumstances, with great care and accuracy, and during recess took a leading share in all duties. Mr. Graham sustained his reputation as an able and trustworthy assistant. Mr. Tate has worked well both in the field and office, and as an artistic draftsman he is unequalled. Mr. Hughes has made excellent progress since he joined the party. Of the sub-surveyors Imam Sharif, K.B., did exceptionally good work.

GUJARAT, AND NASIK AND THANA DISTRICTS, BOMBAY.

No. 17 Party.

82. Throughout the year under report Colonel Pullan retained the charge of this party, which was employed on the following operations:—

(1) The continuation of the general topographical survey on the 2-inch scale of Gujarat.

(2) The survey of the cantonment and environs of Deesa on the 8-inch scale.

(3) The survey of the forests in the Nandgaon, Yeola and Malegaon *talukas* of the Nasik district and in the Thana district, on the 8-inch scale.

Personnel.

Colonel A. Pullan, B.S.C., Deputy Superintendent, 2nd grade, in charge.
Mr. W. Todd, Surveyor, 2nd grade.
„ J. Newland, „ 4th „
„ G. A. Knight, „ Assistant Surveyor, 1st grade.
„ S. F. Norman, Assistant Surveyor, 1st grade.
„ C. Norman, Assistant Surveyor, 1st grade.
„ P. S. Serrao, „ 2nd grade.

Sub-Surveyors.

Gopal Vishnu, G.R. Bhopatkar, Govind Gopal, Bhao Gobind, Balkrishna Babaji, Ganumal, and 28 others.

83. The party was divided into two sections as in the previous season, the forest survey section being under the immediate supervision of Mr. Newland, as before. The field operations were commenced early in November 1887, and were continued till the end of May 1888 when the party returned to recess quarters at Poona.

84. Triangulation for the topographical work was extended over sheets 145, 179 and part of 146, embracing an area of 1,363 square miles of mountainous and heavily wooded country.

85. The area surveyed in detail on the 2-inch scale by the topographical section amounts to 1,085 square miles in sheets 102 and 118. The country in the former sheet is for the most part a sandy plain, offering no obstacles to the surveyor, but the whole of the area comprised in sheet 118 is mountainous, thickly wooded and difficult. A remarkable natural feature was here met with, *viz.*, the cave temple of Menáknath, which lies embedded in the side of a hill 7 miles south-east of Dánta and about $1\frac{3}{4}$ miles north of the small village of Lotal. It is said to be capable of containing 2,000 persons and is a sacred place of pilgrimage for Hindus. Theodolite traverses aggregating 108 miles in length were run over the area surveyed to test the accuracy of the work.

86. The survey of Deesa cantonment and environs on the 8-inch scale was completed over an area of 64 square miles, and was effected with all the minuteness of detail the scale admits. It is comprised in 8 sheets, the fair maps of which have been drawn and submitted to head-quarters for reproduction.

87. The section employed on forest surveys completed an area of 285 square miles of detail survey on the 8-inch scale, in the Thana, Nandgaon and Yeola forests. The work was carried out with the same degree of refinement as that adopted in the previous season's operations, which was described in paragraph 79 of the last annual report, the only change that was made being the larger use of the clinometer in the place of the water level for the determination of contours in the comparatively open and easy tracts in Nandgaon and Yeola.

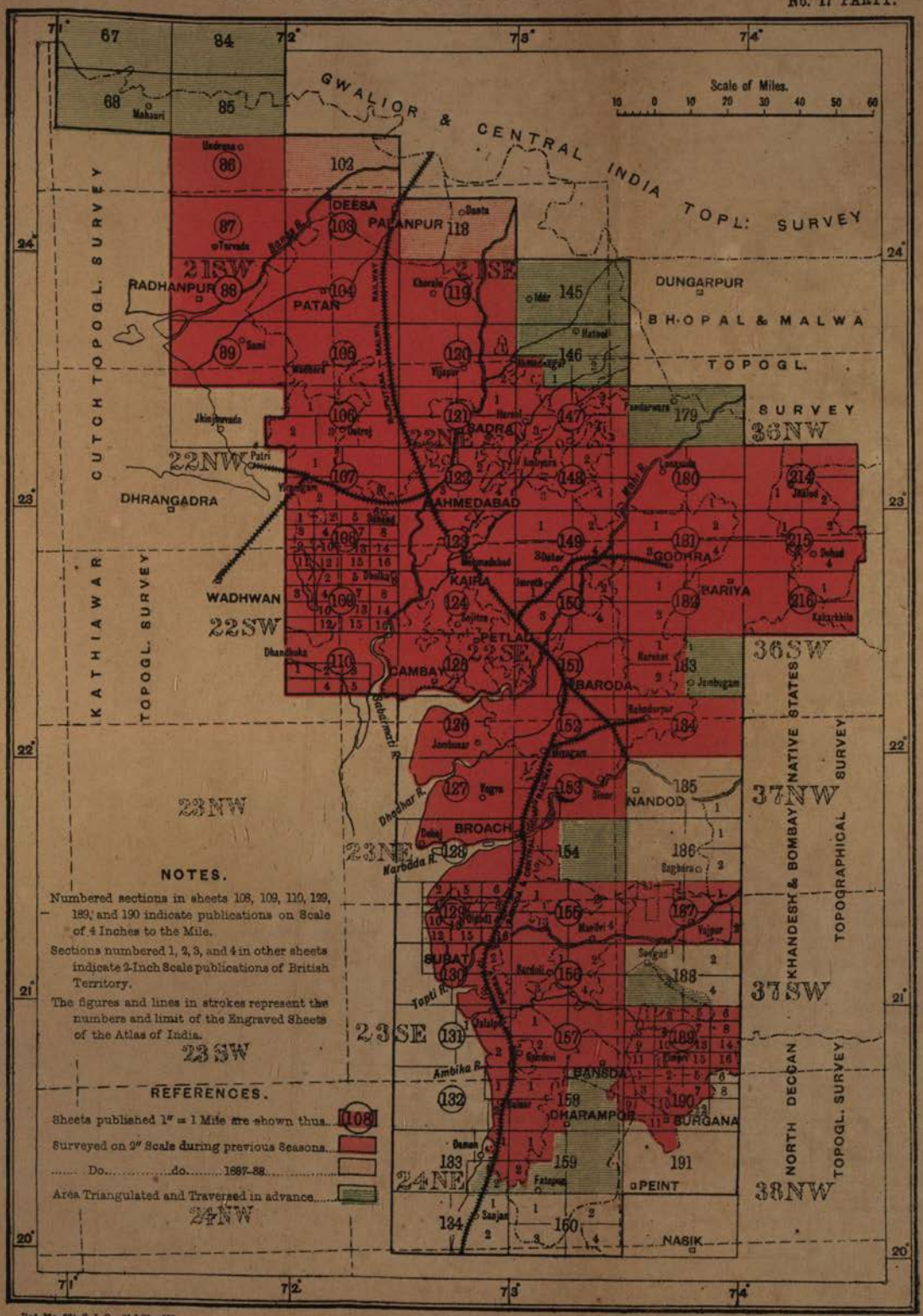
88. The expectation that was expressed in the previous report of this party's forest operations of a considerable increase of out-turn at a much cheaper cost rate has been fully realized, the out-turn being more than five times larger, at a cost rate of R123·7 per square mile against R206·6 of the previous season. This result is due partially to the expansion of the operations which enabled the work to be carried on both in difficult and in easy tracts and partially to the development of the organization of establishment increasing the proportion of the native to the European agency. Credit is due to Colonel Pullan and to Mr. Newland under whose immediate supervision the forest surveys were executed for the satisfactory results that have been obtained.

89. A small detachment from this party under Mr. W. Todd was deputed to the Rajputana Agency and was employed during the earlier part of the field season under Major Wyllie, Boundary Settlement Officer, in surveying portions of the boundary between Meywar and Marwar in the Aravalli Hills which had been long under dispute.

BOMBAY SURVEY.

INDEX TO THE SURVEY OPERATIONS IN GUJARAT.

No. 17 PARTY.



NOTES.

Numbered sections in sheets 108, 109, 110, 129, 189, and 190 indicate publications on Scale of 4 Inches to the Mile.

Sections numbered 1, 2, 3, and 4 in other sheets indicate 2-Inch Scale publications of British Territory.

The figures and lines in strokes represent the numbers and limit of the Engraved Sheets of the Atlas of India.

REFERENCES.

Sheets published 1″ = 1 Mile are shown thus 108

Surveyed on 2″ Scale during previous Seasons

..... Do. ..... do. ..... 1887-88 .....

Area Triangulated and Traversed in advance

REFERENCES

Old Numbers on Sheets	New Numbers on Index
70	86
71	87
72	88
73	89
74	102
75	103
76	104
77	105
78	106
79	107
80	108
81	109
82	110
3	118
4	119
5	120
6	121
7	122
8	123
9	124
10	125
11	126
12	127
13	128
14	129
15	130
16	131
17	132
18	133
19	134
23	145
24	146
25	147
26	148
27	149
28	150
29	151
30	152
31	153
32	154
33	155
34	156
35	157
36	158
37	159
38	160
39	179
40	180
41	181
42	182
43	183
44	184
45	185
46	186
47	187
48	188
49	189
50	190
51	191
52	214
53	215
54	216

Nos. 67, 68, 84 and 85 of Gujarat, correspond to Nos. 42, 43, 57 and 58 of Rajputana Survey.

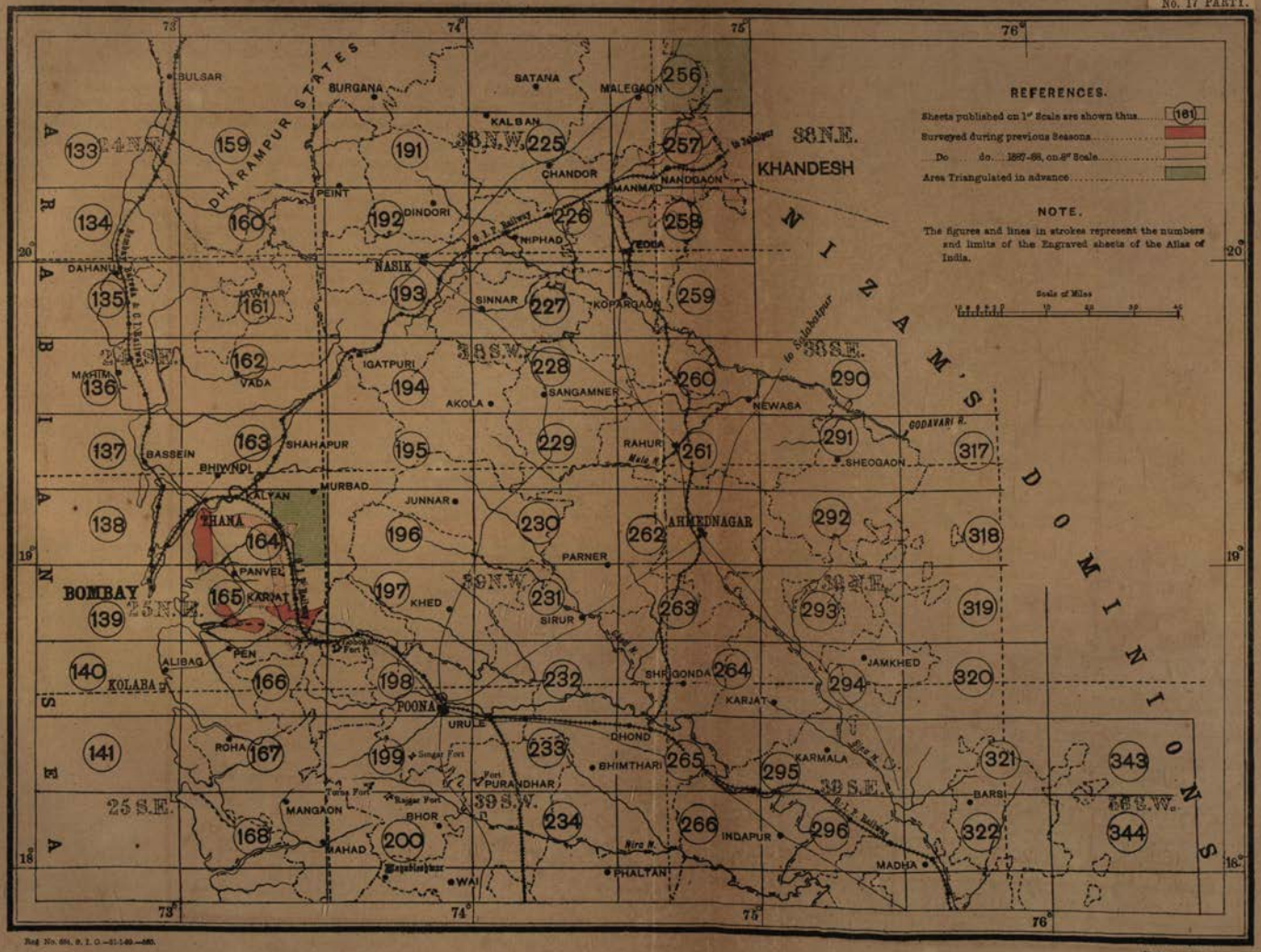
Reg. No. 664, S. I. O.—31-1-89—550.

Photo., S. I. O., Calcutta.

BOMBAY FOREST SURVEY.

INDEX TO THE SURVEY OPERATIONS IN THE NORTHERN DIVISION.

No. 17 PARTY.



Reg. No. 694. S. I. O.—31-1-69.—650.

Photo S. I. O. Calcutta.

90. During the recess season, the computations of the season's triangulation were completed and charts thereof and of the traverses were prepared. The mapping of the 2-inch sections of sheets 102, 118 and 190 for reduction to half scale has been drawn, as well as 8 sections of the survey of Deesa cantonment and environs, for reproduction to scale. Of the forest surveys, the fair maps for reproduction to scale have been drawn of 6 sections of sheet 165 comprising portion of the Thana forests, of 29 sections of sheet 257, and 18 sections of sheet 258 containing portions of the Nandgaon and Yeola forests. Of the Thana forests, the fair mapping of 20 sections in sheets 164 and 165 remained to be completed.

91. The recess office of the party was inspected by the Surveyor-General at Poona in July last, and he was well satisfied with the character of the work which had been executed in the field and with the style of the maps that have been produced.

92. In consequence of the Bombay Government having made proposals to organize a special Forest Survey Branch for the future conduct of forest surveys in that presidency, a conference was held at Poona in July 1888, at which the Secretary to Government of India, Revenue and Agricultural Department, the Surveyor-General and Deputy Surveyor-General attended to discuss the subject with the object of settling a distinct programme for future operations. A general scheme was then arranged and agreed to, of which the following are the principal points, *viz.*:—

(1) One party of the Topographical Survey of India should be placed fully equipped and manned at the disposal of the Bombay Government for the purposes of the Forest Survey of that Presidency to be utilized in such manner as that Government may think fit.

(2) The cost of the party to be debited to "Forests," by which half the cost will be borne by Imperial and half by Provincial Revenues.

(3) The normal scale for the Forest Survey maps to be 4 inches to the mile instead of 8 inches.

(4) The officer in charge of the party to be under the control and supervision of the Survey and Settlement Commissioner, supervision over his work being also maintained by the Surveyor-General of India.

These conditions having been accepted by the Government of India, this party, with slight modifications as to *personnel*, the topographical section having been withdrawn and the forest section from No. 10 Party added, has been placed at the disposal of the Bombay Government for its Forest Surveys, and the programme of operations for the ensuing year will be arranged by that Government.*

* Colonel Pullan reports as follows on his assistants:—

"Mr. W. Todd appears to have conducted the boundary survey in Meywar and Marwar in a satisfactory manner. Mr. Newland did most excellent work in the Nandgaon and Yeola districts in connection with the 8-inch Forest work, and subsequently in recess quarters while supervising the fair mapping thereof. Mr. Knight carried out the triangulation entrusted to his charge in a manner decidedly creditable to him. Mr. S. Norman executed his survey in hilly and wooded country in a very artistic way, and also did good work on the Deesa survey. Messrs. C. Norman and Serrao both worked throughout the season in a most satisfactory manner."

Among the sub-surveyors, Gopal Vishnu, Ganesh Bhopatkar and N. W. Bhopatkar are specially commended.

HIMALAYAS, PUNJAB.

No. 18 Party.

93. Field-work, in continuation of the operations of the previous season, was commenced during November 1887 under the superintendence of Colonel Tanner, and the party remained in the field until the beginning of July 1888.

Personnel.

Colonel H. C. B. Tanner, S.C., Deputy Superintendent, 2nd grade, in charge.
Lieutenant J. M. Fleming, S.C., Assistant Superintendent, 1st grade.
Mr. C. D. Potter, Surveyor, 4th grade.
„ H. T. Kitchen, Assistant Surveyor, 1st grade, up to 2nd July 1888.
Mr. W. Robert, Assistant Surveyor, 1st grade.
„ W. A. Fielding, do. do.
„ P. F. Prunty, do. do.
„ D. Campbell, do. do. up to 16th April.

Sub-Surveyors.

Shah Nasiruddin, | Janki Dass,
Sheik Omar, | Rinzin Nimgyal,
and 17 others.

94. The several operations on which the party is engaged have been described in previous reports, but may be again mentioned for convenience of reference; they are:—

(1) A topographical survey (scale depending on the character of the ground to be surveyed) of the Kángra district, the hill portions of the Umballa and Gurdaspur districts, and of the Hill States about Simla, comprising both British and Feudatory tracts.

(2) Traverse operations to fix the tri-junction points of *mauza** and *tikka* boundaries and other permanent objects therein, so as to afford a suitable framework for the construction of the settlement maps of the British districts by local agency.

(3) The preparation of plots of the above traverse points, intended for use as *patwári* field maps.

(4) The survey of forest boundaries.

(5) The drawing of the fair topographical maps.

The scale of survey adopted for the British tracts, excepting the very high mountainous regions, is that of 4 inches = 1 mile, in which, however, the topographical features to be depicted are confined to the details sufficient for a map on the 2-inch scale. This survey may, therefore, be classed as an exaggerated 2-inch survey. The scale for the Native Feudatory States is 2 inches to a mile, while the very high mountainous regions will be surveyed on the 1-inch scale.

95. During the year under review, the 4-inch open survey was completed in the Shahpur Kandi *taluka* of the Gurdaspur district and was continued in the Kullu sub-division and Palampur *tahsil* of the Kángra district. A small area was also done in the same way in those parts of the Simla Hill States, which adjoin the Morni State, in order to fill up to margin the sheets containing Morni, the survey of which was completed in the previous season. The ordinary 2-inch detail survey was carried out in the Feudatory States of Nalagarh, Mailog and Patiala, comprising part of the Simla Hill States, and in the adjoining hill tracts of the Umballa district, also in the Mandi State. The traversing of Shahpur Kandi and Palampur was completed and the boundaries of all forest blocks met with have been also traversed. Triangulation was carried on in the Simla Hill States, in the Mandi State and in the snowy region of Bara Bangahal.

96. The areas which have been topographically surveyed are as follows:—

	Scale.	Square miles.
District Kángra	4 inches = 1 mile	284
„ Gurdaspur	„ „	116
Simla Hill States	„ „	16
District Umballa and Simla Hill States	2 inches = 1 mile	317
Mandi State	„ „	44
	TOTAL	777

The triangulation has been extended over an area of 1,258 square miles, and the traverse operations comprise 628 linear miles of traversing which was executed

* A *mauza* includes an area within convenient and generally natural limits and all the habitations therein. A *tikka* is a sub-division of a *mauza*.

PUNJAB SURVEY.

INDEX TO THE SURVEY OPERATIONS IN THE HIMALAYAS.

No. 18 PARTY.

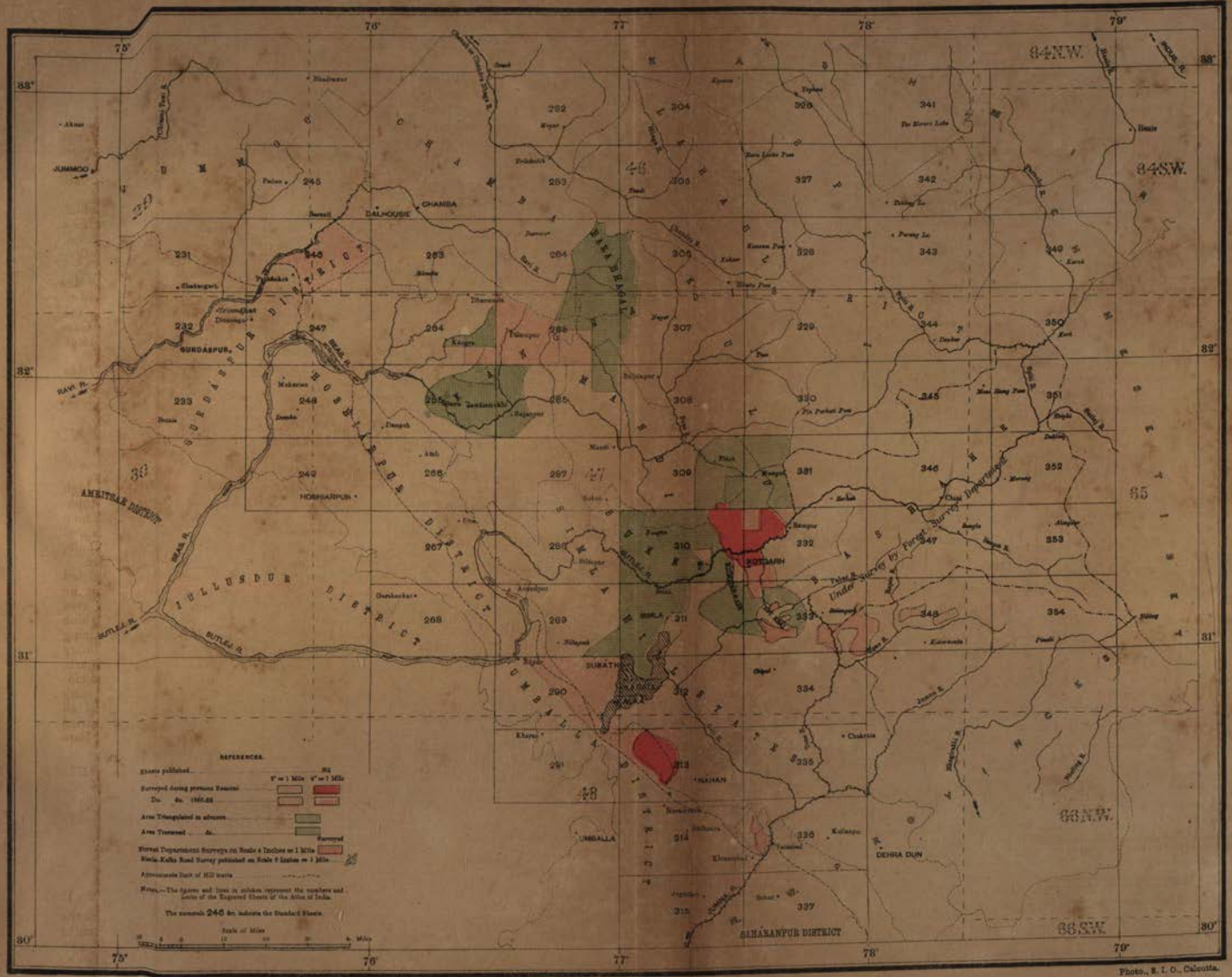


Photo., S. I. O., Calcutta.

by the bar-subtense method with very successful results, the details of which will be found in the extracts from Colonel Tanner's report, page iv of the appendix. In the area topographically surveyed, contours have been determined throughout with the clinometer, at vertical intervals of 500 feet or 1,000 feet according to the nature of the ground. These contours aggregate 2,000 miles in length.

97. Compared with the results of the previous year, the above out-turn of work is satisfactory and the cost-rates thereof are materially diminished. The rates for detail survey on the 4-inch scale and for the triangulation necessary for its execution have fallen from ₹121 and ₹28 respectively to ₹95 and ₹25 per square mile, while for the 2-inch detail survey, the cost-rate has fallen more considerably, *viz.*, from ₹106 to ₹44, the cost of triangulation for the same being only ₹3 per square mile.

98. The instruction of native soldiers in surveying has continued to form one of the duties of this party. The four men attached to it in 1886 and 1887 completed their course of training during the season under report and have been returned to their respective regiments. Colonel Tanner reports that they are quite efficient surveyors, capable, under supervision, of making a fairly accurate map of any country they may be called on to examine or reconnoitre, and it is to be hoped that they will be made to keep up the knowledge they have gained.

99. The demarcation of the forest blocks has been found in many cases to be imperfect and the survey of the boundaries thereof has been conducted under great difficulties, owing to the impossibility of tracing them on the ground. To obviate this in future it has been arranged by the Forest Department to blaze the trees on the boundary lines. The boundary marks, however, are small and imperfectly built and in many places insufficient; the difficulty of finding and fixing the positions of these boundary cairns will still continue.

100. The want of distinguishing marks at the tri-junctions of *mauza* and *tikka* boundaries has also greatly retarded the traverse operations, and it is questionable whether in all cases the correct points have been obtained, as the surveyors were obliged to rely on the village officials for pointing them out, and their information was often untrustworthy. For this reason the civil officers concerned have been warned that the positions of the tri-junctions, as shown on the topographical maps and on the skeleton traverse plots with which they have been provided, must be accepted with caution.

The *mujmilli* maps, which are index maps to villages showing the approximate relative positions of the tri-junctions, were found to be very imperfect and in some cases useless, and owing to this the boundary surveyors lost much time in running traverses over ground where they were not needed. To remedy the difficulty that has been experienced by the traverse surveyors in ascertaining the positions of these obligatory points, the Deputy Commissioner of Kángra has arranged to erect distinguishing marks at such points, and it is hoped that in future there will be no difficulty in identifying them. As stated in para. 89 of the last Annual Report, the traverse survey is now to be confined to such parts of the country as are open and cultivated and where the hills are of moderate altitude, omitting the high mountainous tracts, where the cultivation is much scattered.

101. In the recess good progress has been made with the fair-mapping of the topographical sheets. The traverses in the Shahpur Kandi *taluka*, Gurdaspur district, have been plotted in 170 sheets, on the scale of 26·834 inches = 1 mile, for the use of the Settlement Department, and those in the Palampur *tahsil*, Kángra district, in 110 sheets on the scale of 27·7 inches = 1 mile for the same purpose.

MADURA, TRAVANCORE AND COCHIN, MADRAS PRESIDENCY.

No. 19 Party.

102. This party, of the strength given in margin, took the field during the first week in November, to resume operations in the Madura district in connection with the general topography of the hill tracts and the survey of the forest reserves: also to commence preliminary triangulation in the Native States of Travancore and Cochin, the survey of which had been recently added to the work allotted to this party in the Madras Presidency.

Personnel.

Colonel W. F. Badgley, S.C., Deputy Superintendent, 3rd grade, in charge up to the 20th June 1888.

Major J. R. McCullagh, R.E., Deputy Superintendent, 3rd grade, in charge from the 21st June 1888.

Mr. C. F. Hamer, Surveyor, 3rd grade.
„ A. J. James, „ 4th „
„ H. Todd, „ 4th „
„ R. Todd, Assistant „ 1st „
„ R. W. Senior, „ „ 2nd „
„ T. J. J. Mills, „ „ 2nd „

Sub-Surveyors.

T. Raghava Ayengar,
V. Tiruvenkatsami,
Lachman D. Jadow,
Balaji Dhondiba,
Govindraju Mudliar, and 4 others.

103. The country embraced by the triangulation includes the northern part of Cochin and the northern part of Travancore. It had been arranged that the surveyors engaged thereon should work from their extreme limits towards each other in expectation of effecting a junction; but, unfortunately, the difficulties of the country and the unhealthiness of the climate had been under-estimated, and there remains a gap, which will have to be bridged over at some future time. In addition to the foregoing, the triangulation had to be extended over two portions of the Madura district, *viz.*, in the Palni hills and in the neighbourhood of Dindigul, to afford points for the detail survey of the forest reserves which had been applied for, and which were found to be considerably scattered about the district. The triangulation executed covers an area of 4,535 square miles, of which 1,225 square miles fall in Madura, 1,950 square miles in Travancore and 1,360 square miles in Cochin. In the first two the work is based on the Great Arc Series, and in the last on the final values of Colonel Lambton's Coast Series. Observations were taken at 68 stations, by which 447 points were fixed and the heights of 325 points determined: this, however, does not include any height in Cochin, for, although observations were taken as usual, they could not be computed for want of initial data and must wait until a connection is made with the Travancore portion of the triangulation.

104. In addition to the triangulation, and with a view to an accurate definition of the boundary between the State of Travancore and British territory, as well as of the western limits of a large number of forest reserves in the Tinnevelly district, a theodolite and chain traverse was started from the triple-junction—Madura-Tinnevelly-Travancore—and carried southwards, for a distance of 40 miles, over some of the most difficult ground that such a traverse could well be taken across. Every yard of the way had to be cleared through dense undergrowth; the country was very unhealthy, and several of the men engaged therein succumbed to fever, contracted by fatigue and exposure incurred in this one piece of work.

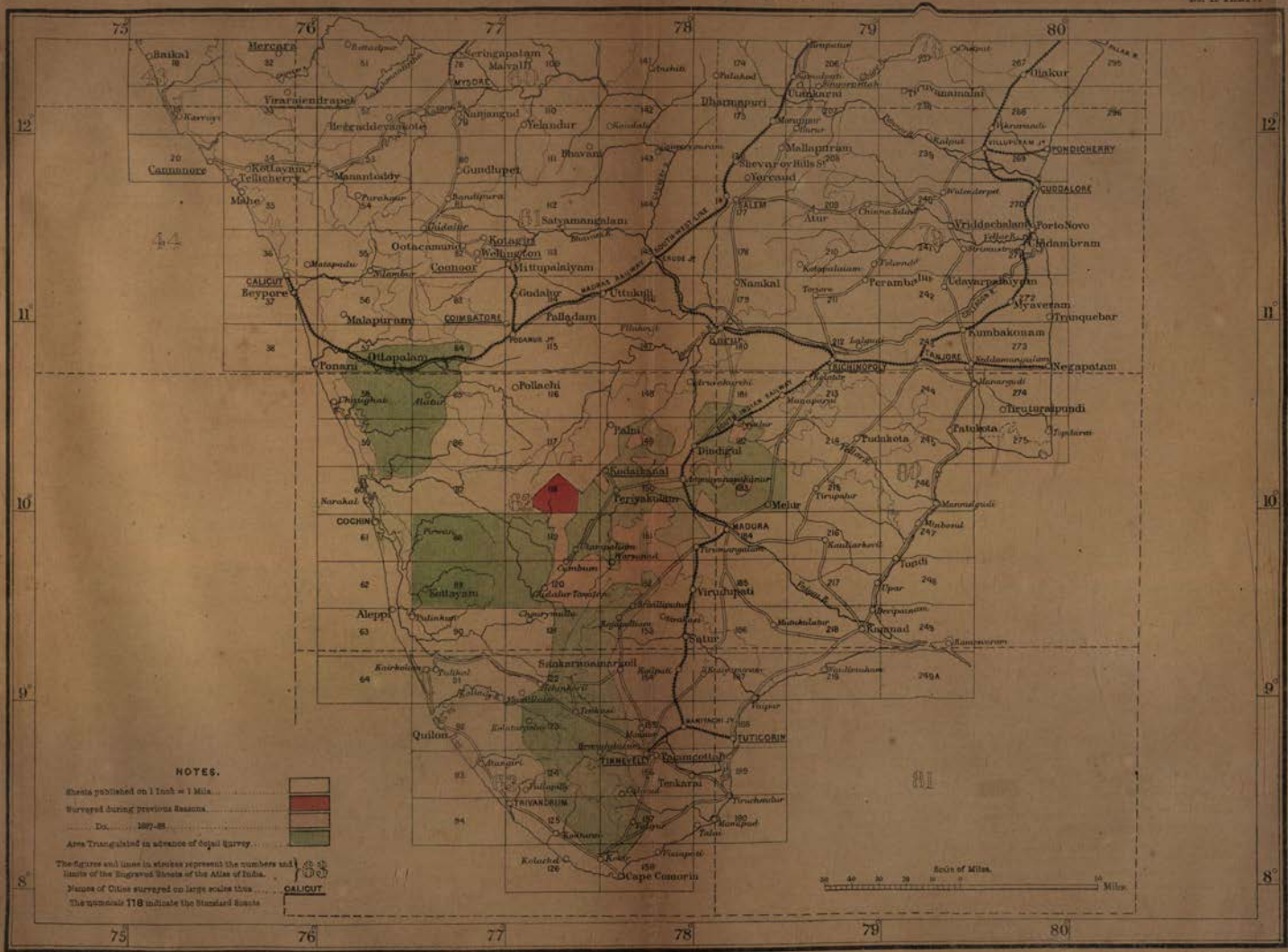
105. The area topographically surveyed on the 1-inch scale covers 1,276 square miles, mostly of mountainous forest-clad country, the greater portion of which may be described as very difficult ground. This includes twenty forest reserves, of which thirteen fall outside the area originally assigned to this party for topographical survey by the Madras Government. In addition to the above work one forest reserve has been surveyed on the scale of 4 inches = 1 mile, with an area of 7·72 square miles. This brings the total area topographically surveyed during the season up to 1,284 square miles.

106. With reference to the survey of these forest reserves, it may be remarked that the scales adopted were in accordance with the requisitions of the local authorities: the work was attended with much difficulty and delay, owing to the discrepancies between the lists furnished to the party, to confusion of names, to imperfect demarcation in some cases, and to the absence of clearly-defined boundaries and of any information regarding them in others; all of which tended to create doubt and uncertainty as to whether the proper reserves were being surveyed, or even whether they were reserves at all. For this reason many of

MADRAS SURVEY.

INDEX TO THE SURVEY OPERATIONS IN MADRAS.

No. 19 PARTY.

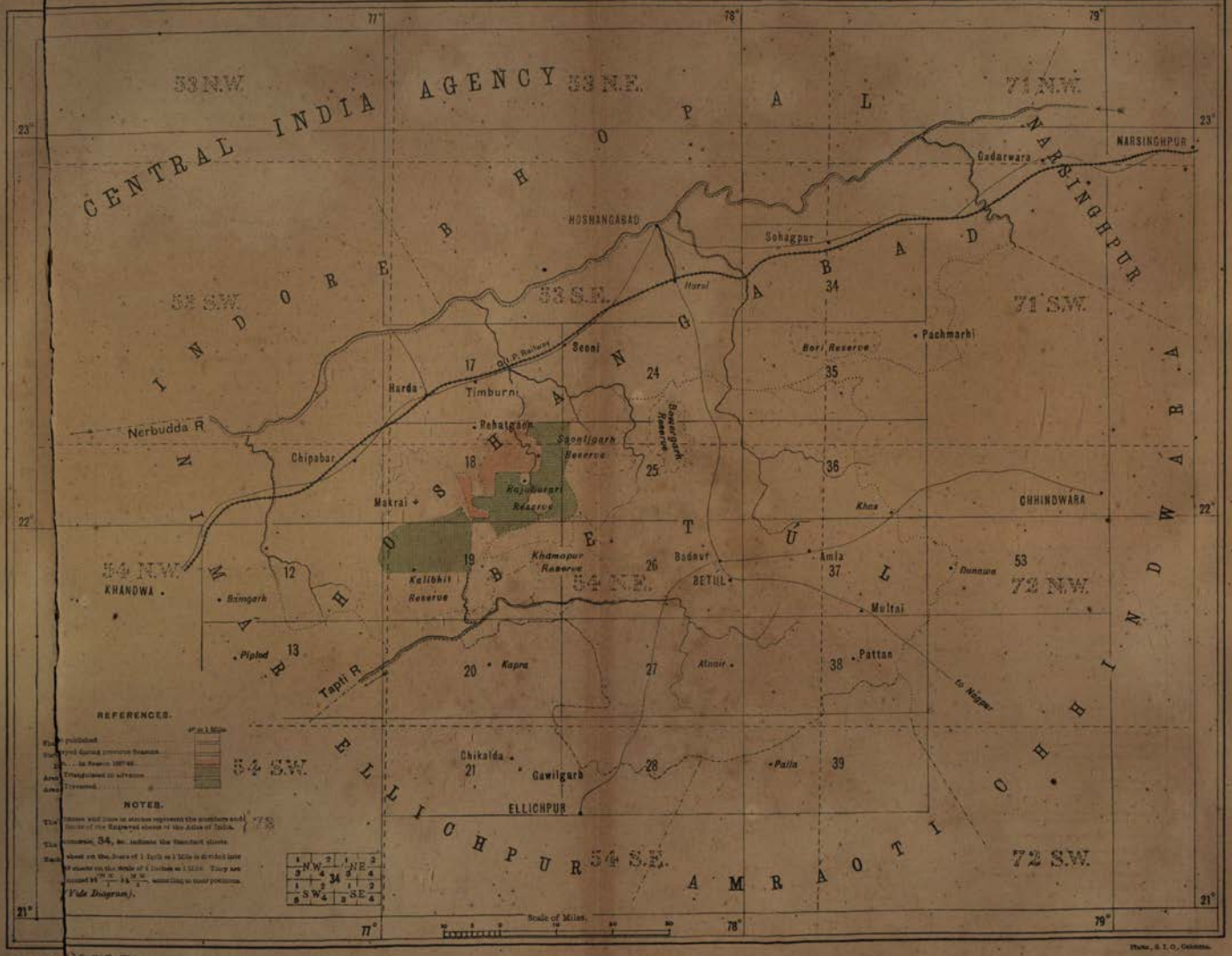


CENTRAL PROVINCES SURVEY.

INDEX TO THE FOREST SURVEY IN DISTRICTS HOSHANGABAD AND BETUL.

On the Scale of 4 Inches = 1 Mile.

No. 14 PARTY.



Plate, S. I. O., Calcutta.

the boundaries, though delineated, can only be regarded as being approximate. Major McCullagh reports that he has now had several consultations with the Conservator of Forests on these points, and that he has expectations that such doubts and difficulties will be removed in the future operations.

107. Of the nature of the country operated in, a full description will be found in the appendix; it may be briefly said that, while a small portion only was easy, a very considerable part was more than ordinarily difficult; nearly every obstacle that could be met with to impede surveying and delay progress was encountered and had to be overcome in the best way possible.

108. The field operations were brought to a close in May, when the weather had become very unfavourable and sickness largely prevailed. The season throughout was one of the worst experienced for some time; hardly a man escaped illness, and there were twelve deaths out of a comparatively small establishment.

109. During the recess season a very large amount of computations have been brought up; seven degree-charts of triangulation were projected, and all the triangulation plotted thereon up to date. There has not been much fair mapping accomplished, owing partly to the scattered nature of the work not allowing complete standard sheets being compiled, and also to the reference to the Madras Board of Revenue, regarding the fair mapping of the forest surveys which were done on the 1-inch scale, not having been settled. Traces of these surveys have, however, in the meantime, been supplied to the Forest Department for immediate purposes.

110. At a conference held at Ootacamund in July last, it was arranged, subject to the approval of the Governments of India and of Madras, to employ the party, in the future, exclusively on forest surveys on the 4-inch scale, owing to the urgent requirements therefor; and as these arrangements have been confirmed, it will, during the ensuing season, be employed on surveys of the forests in the districts of Madura, Tinnevelly and Salem, in which there is said to be an aggregate area of 1,567 square miles of fully reserved and demarcated forest lands ready for survey.

111. The recess office of the party was inspected by the Surveyor-General at Ootacamund in July. The work was found to be well advanced, and being carried out systematically under Major McCullagh's careful management.*

FOREST SURVEYS.

HOSHANGABAD DISTRICT, CENTRAL PROVINCES.

No. 14 Party.

112. At paragraph 50 of last year's report it was mentioned that this party had nearly completed the survey of the Mirzapur district of the North-West Provinces, and would be transferred to the Central Provinces to undertake forest surveys on the 4-inch scale. The transfer was effected at the commencement of the field season under review, under the superintendence of Mr. Patterson, with the establishment given in the margin. The small unsurveyed portion of Mirzapur, amounting to 226 square miles, was made over to No. 4 Party for completion.

Personnel.

Mr. W. H. Patterson, Officiating Deputy Superintendent, 4th grade, in charge up to 1st September 1888.
„ L. Pocock, Surveyor, 3rd grade, in charge from 1st September 1888.
„ A. Christie, Surveyor, 3rd grade, from 1st November 1887.
„ D. Campbell, Assistant Surveyor, 1st grade, from 17th April 1888.
„ F. E. Warde, Assistant Surveyor, 3rd grade.

Sub-Surveyors, &c.

Premraj, Gurdut Singh, Abdul Aziz, and 7 others.
18 Temporary Surveyors and Computers.

113. The district allotted to the party was that of Hoshangabad, and field operations were commenced in the forest reserves therein in the beginning of December 1887, and were continued till the 24th May 1888. Mr. Patterson remained in charge till 1st September 1888, when his services being required else-

* Major McCullagh reports favourably of all his assistants, both European and native, and add "where all did their best, it is not easy to single out any particular member of the party for special mention."

where, he was transferred, and the charge devolved on the senior surveyor, Mr. L. Pocock, as a temporary arrangement.

114. The out-turn of work consisted of 470 square miles of triangulation—369 linear miles of theodolite and chain traverses of boundaries and fire lines, extending over an area of 285 square miles; 64 square miles of topography in full detail, and 36 square miles in outline on the 4-inch scale. The details were tested by the officer in charge and his European assistants, and were found to be good and accurate with rare exceptions. The hills have been contoured by means of the clinometer and a height indicator introduced by Captain R. A. Wahab, R.E. The vertical intervals between the contours thus determined is 300 feet, but others at 25 feet vertical intervals have been interpolated by eye, to show the details of the hill features.

115. The out-turn of the topographical survey has been small, but it was unavoidable that the amount of final work should be curtailed, for, as this was the first season of a new survey, the preliminary operations of triangulation and traversing had to be first undertaken and completed for the area in which detail work was required before the topography could be commenced. The climatic and local circumstances were also most unfavourable to rapid progress, and under the circumstances a larger out-turn was scarcely to be expected. The cost-rate is consequently very high, but considerable experience has been gained, and it is hoped the fruits thereof will be apparent in the next year's report.

116. The country operated in embraces the reserved forests of Rajaburári and portions of the Saonligarh and Kalibhit reserves, which are situated in the Mahádeo Hills. Mr. Patterson reports that the work was carried on under great difficulties; the ground is very intricate, the climate is notoriously unhealthy, supplies had to be imported and water was exceedingly scarce. The hills are all covered with forest, and, in the early part of the season, with long grass also, which greatly impeded the progress of the survey. After January, when the leaves had fallen off the trees and the grass had withered, matters improved somewhat, but in March and April further difficulty was experienced by the migration of the inhabitants, chiefly Gonds and Korkus, who annually desert their villages at that time of the year and proceed to the plains to earn money by cutting crops.

117. The health of the party was throughout the season exceedingly bad, nearly every member of the native establishment having been at one time or other attacked by malarious fever. There were 6 deaths, and 2 sub-surveyors of the permanent establishment were invalided, while the services of 4 apprentice sub-surveyors and 30 *khalásis* had to be dispensed with on account of sickness. This state of affairs also caused a great many desertions among the menial establishment.

118. All the traverse stations at which the theodolite was set up have been permanently marked. At each station two stones have been embedded, one flush with the surface of the ground and the other a foot below it. They are inscribed with a circle and dot and covered with a platform of loose stones, three feet square and one foot high.

119. Three soldier students were attached to the party to be trained in surveying: this was their first season of instruction, and they are reported to have shown aptitude for the work and to have learnt the use of the plane-table and clinometer, but another year's tuition is required to make them thoroughly efficient.

120. During the recess, the fair mapping and chart of triangulation of the field season's operations in Hoshangabad have been brought up to date, but the greater part of the recess work consisted in the fair drawing of the maps of the previous field of survey in Mirzapur, which had unavoidably been left incomplete.

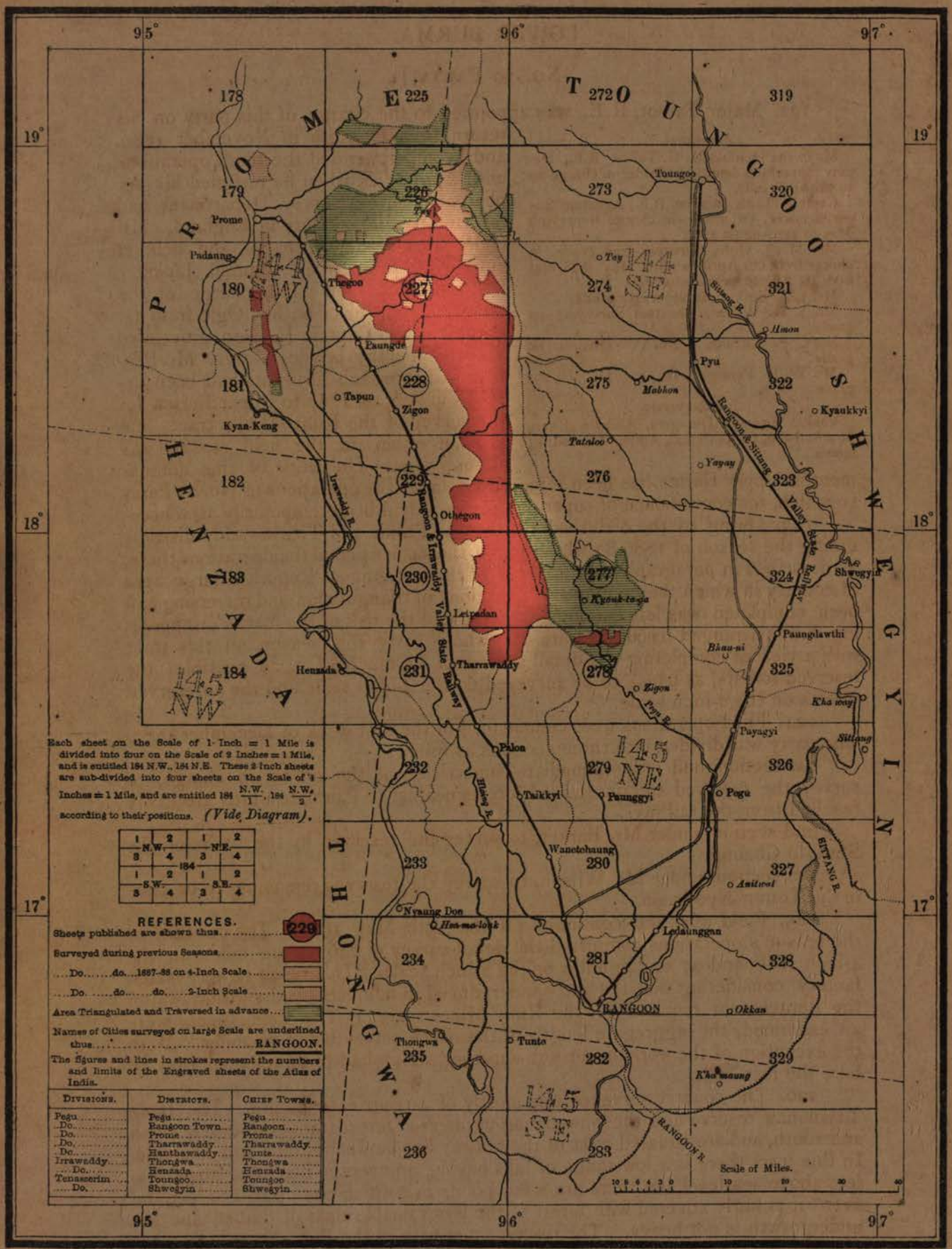
121. The recess office of the party was inspected by the Deputy Surveyor-General in charge Trigonometrical Surveys in September 1888, who has taken measures for the completion of the re-organization of the establishment, due to the change in the character of the survey on which the party had been previously employed, and for proper precautions both as to time of employment in the field and to guard against the bad effects of the climate which the local medical authorities have advised.*

* Mr. Patterson reports very favourably on the services of Messrs Pocock, Christie, Campbell and Warde, and of Sub-Surveyors Premraj, Gurdut Singh, Ram Singh, Sutto Charan Ghosal, and Surjan Singh; also of Mohendro Nath, head computer; Karimdad Khan, draftsman; and Syed Zille Husain and Baijnath, writers.

BURMA SURVEY.

INDEX TO THE FOREST SURVEYS IN LOWER BURMA.

No. 20 PARTY.



Each sheet on the Scale of 1 Inch = 1 Mile is divided into four on the Scale of 2 Inches = 1 Mile, and is entitled 184 N.W., 184 N.E. These 2 Inch sheets are sub-divided into four sheets on the Scale of ½ Inches = 1 Mile, and are entitled 184 N.W./1, 184 N.W./2, according to their positions. *(Vide Diagram).*

1	2	1	2
N.W.		N.E.	
3	4	3	4
184			
1	2	1	2
S.W.		S.E.	
3	4	3	4

REFERENCES.

Sheets published are shown thus..... 229

Surveyed during previous Seasons.....

....Do.....do....1887-88 on 4-Inch Scale.....

....Do.....do.....do.....2-Inch Scale.....

Area Triangulated and Traversed in advance...

Names of Cities surveyed on large Scale are underlined, thus.....RANGOON.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Atlas of India.

Divisions.	Districts.	Chief Towns.
Pegu	Pegu	Pegu
Do.	Rangoon Town	Rangoon
Do.	Prome	Prome
Do.	Tharrawaddy	Tharrawaddy
Do.	Hanthawaddy	Tunte
Irrawaddy	Thongwa	Thongwa
....Do.	Henzada	Henzada
Tenasserim	Toungoo	Toungoo
....Do.	Shwegyin	Shwegyin

Reg. No. 537, 6. I. O.—22-2-89.—350.

Photo., S. I. O., Calcutta.

LOWER BURMA.

No. 20 Party.

122. Major Talbot, R.E., was appointed to the charge of this party on his return from furlough in November 1889, and he superintended the field operations until April 1888, when he resigned his appointment in the Survey Department and reverted to military duty in England. Mr. Ogle then assumed charge and held it until 19th May, when Captain Jackson, R.E., relieved him. The charge of the party again devolved on Mr. Ogle from 1st August, when Captain Jackson proceeded on three months' privilege leave. Mr. Penrose and three sub-surveyors had been deputed in August 1887 to Upper Burma for the survey of the Ruby Mines tract, and did not rejoin till the field season was almost over. The work of this detachment in Upper Burma has been reported on under the operations of No. 21 Party to which, for convenience of superintendence, it had been temporarily attached.

Personnel.

Major the Hon'ble M. G. Talbot, R.E., Deputy Superintendent, 4th grade, in charge up to 5th April 1888.

Captain H. M. Jackson, R.E., Assistant Superintendent, 1st grade, in charge from 19th May to 1st August 1888.

Mr. M. J. Ogle, Surveyor, 2nd grade, in charge from 6th April to 18th May 1888 and from 1st August to end of season.

Mr. J. A. Barker, Surveyor, 4th grade.

Mr. J. H. Wilson, Assistant Surveyor, 1st grade.

Mr. C. P. Torrens, Do. Do., 1st grade.

Mr. W. H. Penrose, Do. Do., 1st grade.

Sub-Surveyors.

Venkat Swamy, Doorgiah, Abdulla Khan, Sharf-ud-din, Girdhari Lal, Amjad Ali, and 13 others.

123. Owing to the disturbed state of the Prome and Tharrawaddy districts during the season of 1886-87 which led to the suspension of the operations there, as described in paragraphs 117 and 118 of the last Annual Report, a large area of country in which the preliminary operations of triangulation and traversing had been completed was left untouched. To avoid the risk of the marks disappearing, it was arranged to concentrate the whole party this season on this tract with a view of completing the detail survey of as much of it as possible: the reserved forests, as usual, to be surveyed on the 4-inch scale and the unreserved forests on the 2-inch scale.

124. Field operations were commenced in the first week of December 1887. The party was divided into three sections as follows:—

1st section, under the immediate supervision of the officer in charge, to survey the reserved and unreserved forests nearest to Paungdé which are easily reached from the railway.

2nd section, under Mr. Barker, to survey the reserves in the basin of the Shwe-lé Chaung.

3rd section, under Mr. Wilson, to survey the reserves remaining to be done in the Toung Nyo basin.

125. Field work was continued till the 19th May 1888. The out-turn of the season's operations comprised the detail survey of 246 square miles on the 4-inch scale and 97 square miles on the 2-inch scale. This result is very satisfactory, considering that the party was reduced in numbers by the withdrawal of the detachment required for the Ruby Mines survey. The field sheets were all examined, the aggregate length of the check survey being 79 miles. With the exception of the work of one sub-surveyor, which had to be rejected, they all bore the test well.

126. The country surveyed was mostly of an intricate nature. The Inma Tayokmaw reserve and the Shwedaung unreserved forest tracts run nearly north and south, and are situated west of the railway line between Prome and Paungdé. In this tract there is a low range of hills having an average height of about 200 feet above sea-level, but there are a few points in it which rise up to 450 feet and over: it is fairly covered with forest of the less valuable class of timber, and the undergrowth is not heavy. The reserves met with in the Pegu Yoma are more formidable for survey. This range rises in places to 2,000 feet; it is densely wooded and has much undergrowth.

127. Major Talbot reports that the arrangements made for the season's operations by Mr. Horst, late in charge of this party, on whom these duties devolved, were all that could be desired and proved quite successful, and that the improvement in the out-turn is simply due to the pacified state of the country,

which permitted the operations, with some few trifling exceptions, to be carried on unremittingly. The original programme of work laid out has been exceeded in quantity. As in previous years, the progress improved as the weather got warmer owing to the jungle becoming more open; on the other hand, much difficulty was experienced in the hot season on account of the scarcity of water, which frequently obliged the surveyors to camp inconveniently far from their work. The only point in which it was considered desirable to make any alteration in the system was in the matter of the duties of the European assistants, whose responsibilities have now been increased in respect to the progress and out-turn of the sub-surveyors attached to their respective sections. Instead of expecting a tale of individual mapping from the European assistants, which class of work the native sub-surveyors have proved themselves to be quite capable of performing, they are now utilized as supervising officers and are made responsible for the quantity and quality of the work of the natives placed under their control.

128. The arrangements for provisioning the several sections required special care, as usual. Provision depôts were established, one at Nyaungle-bin and the other at Yoksein, which were both fed from Paungdé. Later in the season they were both moved to Taunglé Zigôn about 34 miles east of Prome.

129. The party was provided with a police guard, consisting of 1 Havildar, 5 Naiks, and 26 constables, furnished by the Inspector-General of Police, and Major Talbot reports on them as follows:—

"With the exception of the Havildar all the men were especially enlisted for the job and are under no Enlistment Act; that is to say, they are liable to no punishment, except forfeiture of pay or dismissal for any offence, such as insubordination or desertion.

One Naik, by his want of tact, drove four constables to ask to be dismissed and a fifth left because his brother had gone. The Naik himself was returned to Rangoon, having been guilty of drunkenness, insubordination, and misappropriation of the sum of ₹40 entrusted to him by a sub-surveyor. This is an example of the evils attending the present system of enlisting the survey guard. The individual in question had been appointed by the police authorities to act as Naik, because he appeared a smart fellow, but necessarily without anything being known as to his character.

The men of the guard have, however, on the whole behaved fairly satisfactorily. Their fighting qualities have not been tested, but, considering what a raw lot they were when they arrived, they have given little trouble."

130. The recess office opened at Rangoon on the 27th May and the fair maps of the season's operations have been drawn. These comprise 19 sheets on the scale of 4 inches to a mile for reproduction, and 4 sheets on the scale of 2 inches to a mile for reduction to half scale for general purposes.

131. The Chief-Commissioner having decided to retain this party in Lower Burma to continue forest surveys, it will be employed according to the requirements of the Forest Department in the districts of Prome, Toungoo and Thayetmyo. As this was not anticipated, no arrangements had been made for extending the preliminary operations during the season under report, and consequently a small area only is ready for detail operations, *viz.*, 45 square miles for 4-inch survey and 200 square miles for 2-inch survey. Special arrangements are, however, being made to push on the triangulation and traversing early in the season, and it is hoped that by the time the available ground is surveyed, new work will be ready for the detail surveyors. The 4-inch survey will be carried out in continuation to the north and east of that which has been already completed, while the 2-inch survey will be limited to the gaps between the 4-inch work and the cadastral survey work. The out-turn of detail survey under such circumstances cannot be as large as usual, but it is hoped that an area of about 170 square miles on the 4-inch and 100 square miles on the 2-inch scale may be accomplished. Lieut.-Colonel Beavan, who returns from furlough early in December, will be placed in charge of these operations.*

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* Major Talbot reports on the services of his assistants as follows:—

"Mr. Barker, though new to the party and in some degree to the class of work, has managed his section very satisfactorily.

"Mr. Wilson completed the work in the Toung Nyo basin under considerable difficulties owing to his section being reduced to about half its contemplated strength. The portion assigned was nevertheless completed very satisfactorily, which reflects great credit on his management. His long acquaintance with the *personnel* of the party and experience of this class of work has been most useful to me when, as frequently has happened, I have applied to him for advice and information.

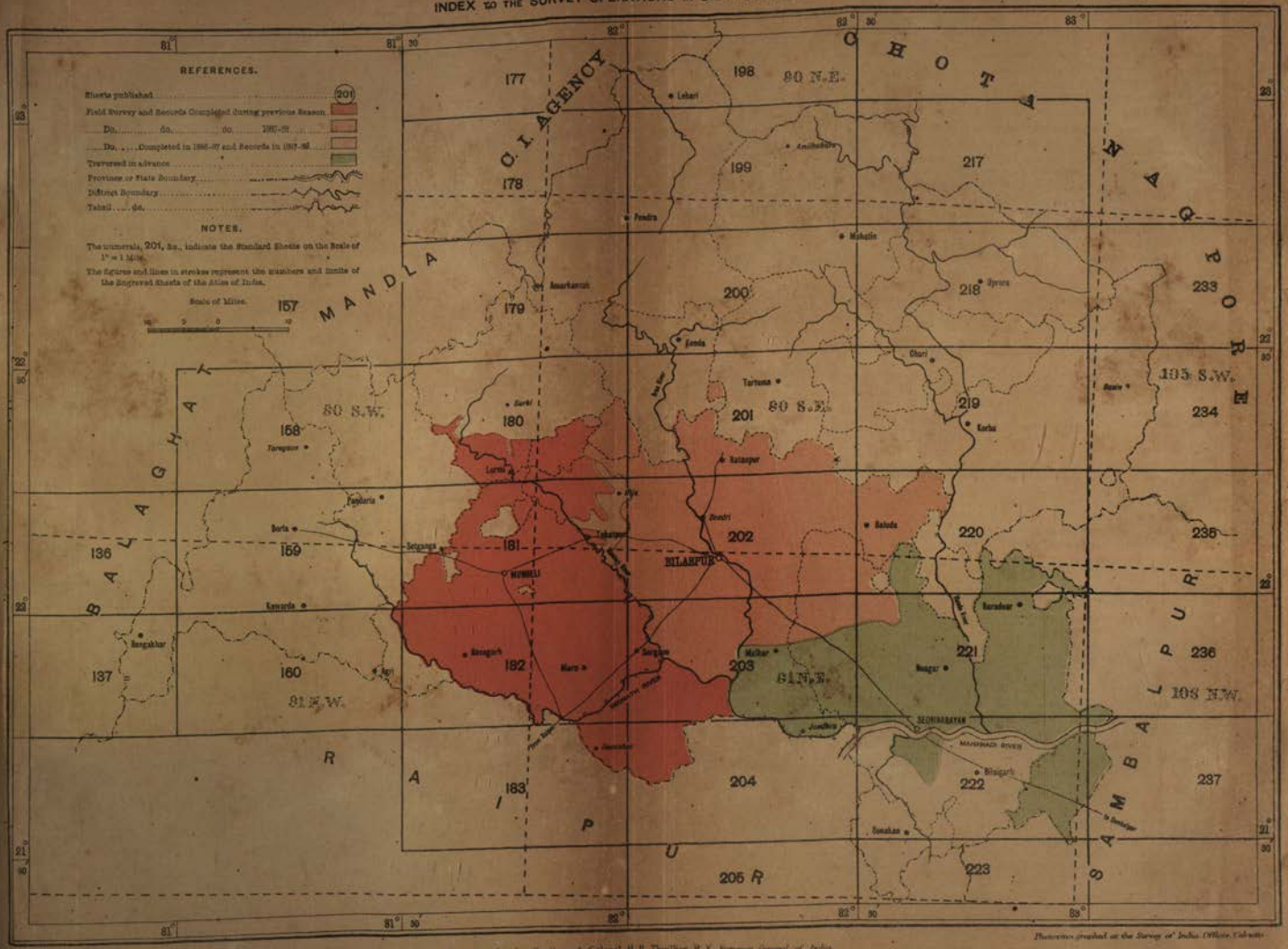
"Mr. Torrens has worked very hard to acquire a knowledge of topography and was subsequently entrusted with the supervision of No. 1 section, which duty he has carried out very satisfactorily."

Of the sub-surveyors, Abdulla Khan, Sharf-ud-din, and Girdhari Lal are reported to have worked well.

CENTRAL PROVINCES SURVEY.

INDEX TO THE SURVEY OPERATIONS IN DIST. BILASPUR.

No. 2 PARTY.



Published under the direction of Colonel H. R. Thuillier, R. E., Surveyor General of India.

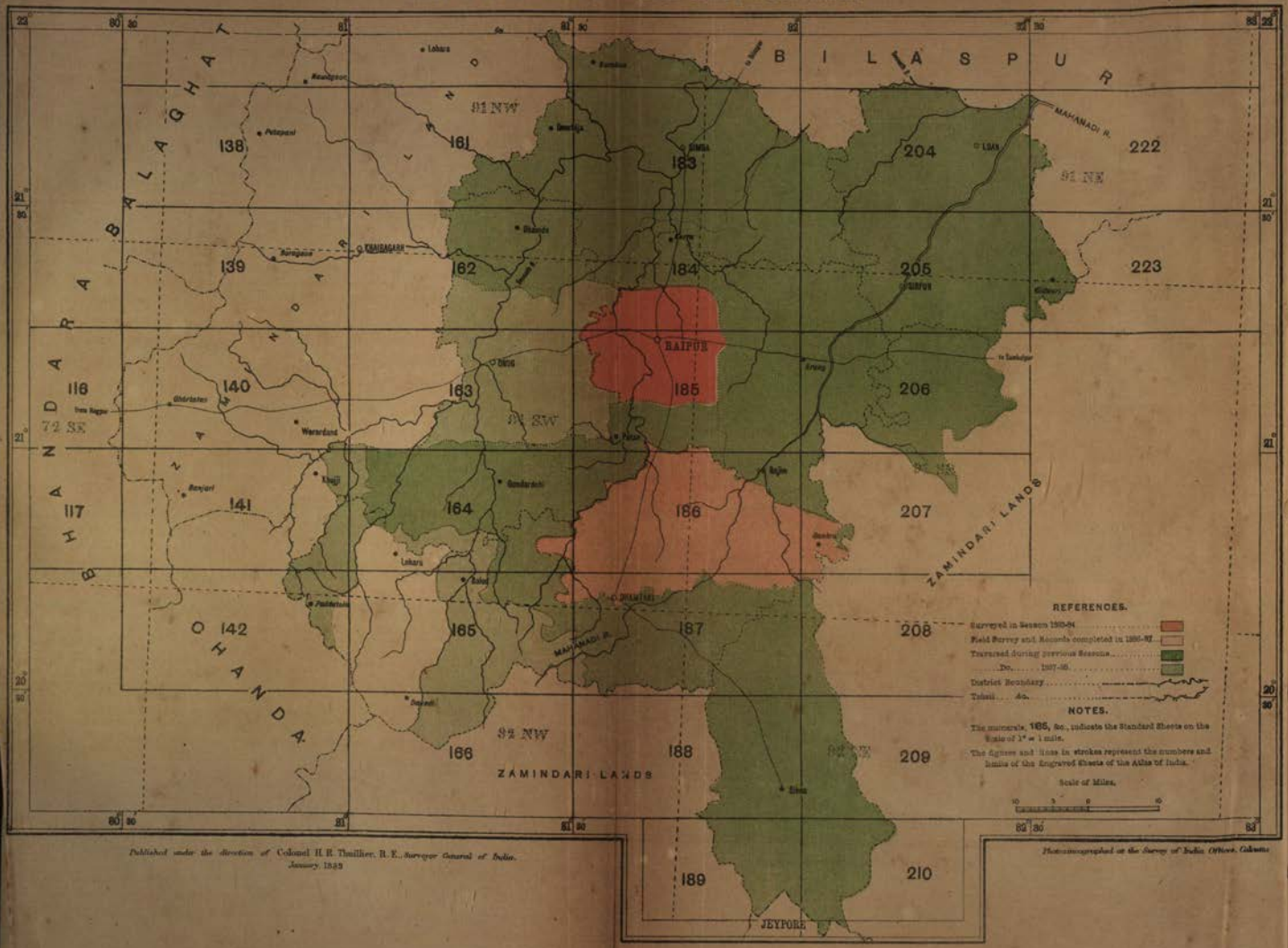
Survey 1899

Photozincographed at the Survey of India Offices, Calcutta

CENTRAL PROVINCES SURVEY.

INDEX TO THE CADASTRAL & TRAVERSE SURVEY IN DIST. RAIPUR.

Nos. 2 & 3 PARTIES.



Published under the direction of Colonel H. R. Thuillier, R. E., *Surveyor General of India.*
January 1895

Photozincographed at the Survey of India Offices, Calcutta.

CADASTRAL SURVEYS.

BILASPUR DISTRICT, CENTRAL PROVINCES.

No. 2 Party.

132.. The charge of this party has again been assigned to Lieutenant-Colonel E. H. Steel on his return from medical leave and Colonel Steel relieved Mr. G. B. Scott on 24th November 1887. Mr. Scott was then transferred to the charge of the Srinagar Ward's estate survey in Bengal; and the party was at the same time deprived of the services of Mr. J. R. Scott, Assistant Surveyor, an excellent section officer, who was transferred to the settlement staff of the Central Provinces for employment on settlement surveys. The European staff of the party was still further reduced during the recess season by the appointment of Mr. F. Grant, Surveyor, to the temporary charge of No. 9 Party from 1st August. Field work was resumed on 15th November 1887 and was continued up to 10th April 1888. A division was then made of the recess office similar to that of the previous season, the establishment for the completion of the vernacular records being taken to Kamptee and left there in charge of Mr. J. McHatton, Assistant Surveyor, while the establishment for the area computations and for completing the drawing of the maps was taken to Mussooree under charge of Colonel Steel.

Personnel.

Lieutenant-Colonel E. H. Steel, S.C., Officiating Deputy Superintendent, 3rd grade, in charge from 24th November 1887.
Mr. G. B. Scott, Assistant Superintendent, 1st grade, in charge up to 23rd November 1887.
„ F. Grant, Surveyor, 1st grade, up to 31st July 1888.
„ J. R. Scott, Assistant Surveyor, 1st grade, up to 11th December 1887.
„ J. McHatton, Assistant Surveyor, 1st grade.
„ C. S. Kraal, Assistant Surveyor, 1st grade.
„ P. C. H. Smart, Assistant Surveyor, 2nd grade.
„ F. W. Moore, Assistant Surveyor, 2nd grade.
„ J. P. Barker, Assistant Surveyor, 2nd grade.
17 Sub-Surveyors and others.

Temporary Establishment.

114 Field Surveyors and others.

133. The cadastral survey has been carried on exclusively in the Bilaspur district. Boundary traversing has been done partly in Bilaspur and partly in Raipur, under an arrangement whereby on account of the area remaining to be traversed in Bilaspur being insufficient to furnish employment for the traverse section for the whole season, the completion of the traversing of the Raipur district for the purposes of the settlement survey has been taken over from No. 3 Party.

134. The following statement shows the work that has been done in connection with the cadastral survey:—

District.	Records written only (Khanapuri) surveyed during season 1886-87.		Cadastrally surveyed and records written.		Cadastrally surveyed only.	
	Number of villages.	Area. Square miles.	Number of villages.	Area. Square miles.	Number of villages.	Area. Square miles.
Bilaspur	33	33·56	587	1029·27	3	14·54

135. The following statement shows the traversing which has been executed for next season's cadastral survey in Bilaspur and for the settlement survey in Raipur:—

District.	Number of villages.	Number of Stations.	Area square miles.
Bilaspur	370	5,667	550
Raipur	547	13,122	996

136. A change has been made in the plan on which the field registers (*khasras*) have been prepared, which has considerably reduced their cost. Hitherto the

system has been for each separate plot of land to be treated as a separate *khasra* number with full particulars of occupancy right and classification of soil recorded against it, thus involving many unnecessary repetitions of entries when adjoining plots are under all conditions entirely similar; and this system has now been changed for one of recording under one number in the *khasra* and on the map the plots which touch one another, and are under the same tenure crop and soil. Thus, while each plot has still been surveyed and exhibited separately in the map, the drawing of the field boundaries has been made distinctive to correspond with the *khasra* numbers. The result has been that, while there are 108,600 surveyed plots, the *khasra* numbers have been reduced to 663,500.

137. As regards the survey, there have been 769 linear miles of check lines done after the maps were completed, and 1,053 miles done during progress of the measuring. As regards the records, the checks by the European officers and superior native officers have been carried out for 82,317 numbers, and the checks by the subordinate native officers were for 185,920 numbers.

138. Regarding the classification of soils, Colonel Steel writes as follows:—

"Of our difficulties, that of soil classification was the most marked, and I think this proceeds from so many of our men being town-bred. But at the same time I am bound to add that the *patwáris*, whom the settlement officer placed at my disposal for marking soil *chaks*, were quite as much at fault as the *amins* in discriminating between the different classes of soil where one merged into the other."

139. Besides the *amins*, who had been brought down from the North-West Provinces, the party employed a small number of the district *patwáris* who were made over by the settlement officer to be trained and then to be used as part of the surveying staff, but of 60 men who had been sent for instruction, 38 only were found fit to be retained throughout the season, and the daily average rate of their work was only about one-third in amount to that of the professional *amins*.

140. The total cost-rate under all heads of the several operations of traversing, marking stations, detail survey and record-writing (of which the separate rates are given in the Table at page 76) is R114-12-1, which shows a decrease of about R18 on R132-13-7, the rate of last year.

141. Regarding the co-operation of the settlement officer, Mr. Parshotam Dass, Colonel Steel writes—

"I am indebted for his unceasing assistance in my work. I take this opportunity of expressing the great obligation I am under to him, and I would add that I have invariably obtained the expression of his wishes on every point connected with the survey before adopting any new procedure.

142. The recess office of the party at Mussooree was inspected during September by the Deputy Surveyor-General in charge of the Revenue Branch who specially reports on the exertions during the field season of Colonel Steel and of his European officers to ensure the accuracy of the entries in the village papers by persistent checking during the progress of the writing of the records.*

* Colonel Steel, in reporting on the services of the European officers, specially commends Messrs. F. Grant and J. McHatton, who held charge of sections, and mentions that the Assistant Surveyors, Messrs. P. C. H. Smart and F. W. Moore, have worked to his entire satisfaction.

Meesrs. E. McGowan and F. Berkeley, temporary employés, are also well reported on.

Of the native staff, Sub-Surveyors Latifulla Khan and Hilaludin, and Accountant Pandit Ramji Lall are specially mentioned.

NORTH WEST PROVINCES SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT BASTI.

No. 4 PARTY.

Photo., S. I. O., Calcutta.

BASTI AND MIRZAPUR DISTRICTS, NORTH-WEST PROVINCES.

No. 4 Party.

143. The area remaining for cadastral survey in the Basti district being sufficient to furnish employment for only one section of this party, it became necessary to assign work for two sections in other districts. The second cadastral section was therefore transferred to district Mirzapur to take over from No. 14 Party, the cadastral survey of *talukas* Chakia and Naugarh of *pargana* Kera Mangror, being parts of the family domains of the Maharajah of Benares (the traverse survey of which had been executed during the previous season), as well as to relieve No. 14 Party on its transfer to the Central Provinces of the area in Mirzapur remaining to be surveyed topographically. To this section was likewise assigned the cadastral survey of the permanently-cultivated tracts in *pargana* Dudhi of Mirzapur, ordered by North-West Provinces Government No. $\frac{1139}{1-54}$A, dated 30th August 1887, for which skeleton traverse maps were held in readiness by No. 14 Party under special instructions issued at the time that party undertook the topographical survey of the *pargana*.

Personnel.

Lieutenant-Colonel S. H. Cowan, S.C., Deputy Superintendent, 3rd grade, in charge from 1st October 1887 to 24th January 1888 and from 5th May to 3rd July 1888.
Major J. R. McCullagh, R.E., Deputy Superintendent, 3rd grade, in charge from 25th January to 4th May 1888.
Mr. H. T. Hanby, Surveyor, 3rd grade, in temporary charge from 4th July 1888.
„ W. C. Price, Surveyor, 3rd grade.
„ L. F. Berkeley, Assistant Surveyor, 1st grade.
„ R. F. Warwick, do. do. 2nd grade.
„ W. E. Johnson, do. do. 3rd grade.
16 Sub-Surveyors and others.

Temporary Establishment.

255 Field Surveyors and others.

144. The third or traverse section for which there was no further employment in the North-West Provinces was transferred to Bengal to initiate the survey of the Srinagar-Banaili estate in districts Bhagalpur and Monghyr, and it became the nucleus of a small cadastral party, when it was entirely separated from No. 4 Party. This section took the field early in October in order to get traverse plots ready in good time for the new cadastral survey.

145. The Basti and Mirzapur sections commenced their respective field operations during the last week in October and both closed work in the last week in April, when they returned to recess quarters at Naini Tal. The office establishment for completing the vernacular records and compiling the statistical statements for the Basti district was left in the plains as usual, and this year was located at Fyzabad, which was the nearest station where accommodation could be procured. Mr. W. E. Johnson was left in charge of this office. Lieutenant-Colonel Cowan held charge of the party from the beginning of the season up to 24th January 1888, when, on his proceeding on 3 months' privilege leave, he made over charge to Major J. R. McCullagh, R.E., who had been temporarily appointed to the party on returning from furlough, and Colonel Cowan received back the charge on the 5th May 1888. Another change in the superintendence took place during the recess, when on Colonel Cowan's being transferred temporarily to No. 8 Party he made over charge to Mr. H. T. Hanby.

146. The out-turn of 16-inch cadastral survey in district Basti is shown in the following statement:—

District.	Pargana.	Number of villages.	Number of fields.	Area in square miles.	Remarks.
Basti	Bánsi East (part) .	494	4,35,503	262·25	Three villages in Bánsi West have been surveyed on the 32-inch scale on account of the very small size of the fields.
	Bánsi West (part) .	299	4,79,017	180·39	
	Binayakpur .	109	73,059	48·44	
	Total .	902	9,87,579	491·08	

147. The average size of the fields is 0·318 of an acre (giving 2011 fields to the square mile), which is remarkably small though slightly larger than the average of last season which was 0·268 of an acre. In some parts of *pargana* Bánsi West,

however, the average is as low as 0·15 of an acre, owing to a peculiar tenure under which communities of cultivators hold the occupancy rights in certain plots which have been sub-divided into "fields," each bearing a separate rental in accordance with the amount of each man's share in the common interest. The plots are usually sub-divided in strips, some of which were met with averaging only 5 to 6 links in width. On account of these very small fields, three villages were entirely mapped on the 32-inch scale; and many parts of other villages were mapped on this enlarged scale (and sometimes larger) on the margins of the 16-inch maps.

148. In rice lands the practice hitherto adopted in the Basti district has again been followed for the *kiaris* (sub-divisions of "fields" for cultivating purposes), to be surveyed but mapped in a distinguishing manner, and for the "fields" only to be numbered on the maps and *khasras*. It was very desirable that the numbering should be restricted to the true "fields" only, so that the *khasras* and other papers might not be rendered unnecessarily voluminous by the numbering of *kiaris*, and maps and old papers had often to be referred to as guides to the "field" boundaries, which in appearance are the same as the boundaries of the *kiaris*. In excess of the 987,579 "fields" which have been numbered, 639,567 interior sub-divisions have been surveyed.

149. The detail survey was tested by 1,426 linear miles of check surveys, and the *khasra* entries of 258,031 fields were checked either by European officers or by responsible native Inspectors. Regarding the value of the village papers prepared by the Survey party during previous seasons, the Settlement Officer of Basti, in illustration of the satisfactory manner in which the rights of the occupancy tenants have been safeguarded against the designs of the *zamindárs*, has furnished the following tabular statement of areas recorded in the papers of different "Fasli" years :—

Pargana.	Areas held by Occupancy Tenants.			
	According to annual statements prepared in the Office of District Sadár Kanungo.			According to survey records after attestation by settlement.
	F. year 1289.	F. year 1290.	F. year 1291.	F. year 1292.
Amorha	22,094	23,212	14,447	32,935
Nagar West	12,251	12,399	13,585	19,449
Basti West	9,061	9,372	7,362	13,761
Nagar East	3,275	13,925	6,844	17,468
Basti East	7,085	8,272	2,412	16,586
Total	53,766	67,180	44,650	100,199

Alluding to the above, the Settlement Officer writes—

"There is another fact worth noticing. In four out of the five *parganas*, the area shown is much less in the year 1291 (the year before survey) than in previous years, which shows that the *zamindárs* had got the *patwáris* to enter a number of occupancy tenants as 'non-occupancy' in the hope that they would be similarly recorded by the survey. The figures for 1292 show what a failure the attempt was."

150. In accordance with the requisition of the Resident in Nepal, made under authority from the Government of India, the portion of the frontier boundary between the Basti district and Nepal territory from pillar No. 34 to pillar No. 46 has been rectified by straight lines being laid out from pillar to pillar, instead of adopting the road running near the direct lines which has hitherto been used as the boundary. By the rectification 53·77 acres have gone over to Nepal and 21·81 acres have come into British territory.

151. Messrs. Taylor and Colman, junior officers of the Civil Service, were attached to the Basti camp for two months during the field season and received the usual instruction in the various processes of survey. Twelve district *kanungos* also received instruction in surveying.

152. Traces of the cadastral maps (of which there are 880) and the papers of all the villages, except three on which there are disputed boundaries, were

furnished to the Settlement Officer before the end of the recess. The original maps are also completed except of the same three villages, but they cannot be finally lodged in the Head-Quarters Office for printing, until, as has been the procedure in previous seasons, the Settlement attestation has been carried out. The drawing of the 2-inch district maps, of which 19 remained over at the end of the previous recess season, has now been nearly finished, and some of them will, it is expected, soon be published on the 1-inch scale in accordance with the design of the drawing. Several of the maps will, however, have to be kept back until the portions of the Gorakhpur district which fall in the same standard size sheets have been drawn.

153. The cadastral survey of the Basti district has now been completed, having been begun in season 1883-84, and it has occupied the entire establishments of No. 4 Party for three seasons and part of the establishment for two seasons, as is shown in the following statement giving the particulars of the work, to which the final account showing the cost and the cost rates cannot yet be added, as is usual, a further expenditure for the drawing of the maps having to be included. The total area given for the district is not final, a change of boundary on the Gogra river having recently been ordered.

Particulars of the Cadastral Survey of District Basti.

Season of Survey.	No. of Villages.	No. of Fields.	Area in square miles.	No. of Cadastral sheets.	Remarks.
1883-84 . .	309	197,031	100·66	185	The operations of the survey have included the preparation of the several village papers constituting the Record of Rights and 9 Statistical Statements for each *tappa*.
1884-85 . .	2,172	1,102,226	666·58	1,402	
1885-86 . .	2,276	1,126,230	783·04	1,602	
1886-87 . .	1,956	1,847,354	774·20	1,535	
1887-88 . .	902	987,579	491·08	880	
Total .	7,615	5,260,420	2,815·56	5,604	

154. As previously mentioned, the detachment of the party, which has been employed in the Mirzapur district, had to undertake three distinct operations, *viz.*, (1) the cadastral survey of *talukas* Chakia and Naugarh; (2) the topographical survey of portions of the same *talukas;* (3) the cadastral survey of the permanent cultivation in *pargana* Dudhi.

155. The cadastral survey of Chakia and Naugarh had been specially asked for by the Maharajah of Benares to be done at his expense, in place of a topographical survey which had been intended for the family domains, the same as for other *zamindáris* in the Mirzapur district. The greater part of *taluka* Chakia is a level well-cultivated tract in the Gangetic plain, sub-divided into numerous small *mauzahs*, and the whole plain part of the *taluka* was required to be surveyed cadastrally excepting a few detached blocks of reserved forests; while the hilly part situated on a tract overlooking the plain was left to be surveyed topographically. *Taluka* Naugarh is entirely situated in the same hilly tract, and in this area the cadastral survey, though first begun for all constituted *mauzahs*, was afterwards restricted to the scattered plots of lands actually under cultivation; by which restriction, which was asked for by the Maharajah in order to reduce the cost to the lowest possible amount, the 16-inch maps show merely the dimensions of the existing fields and are of no value as representations of any extent of country on a large scale.

156. The topographical survey, the second operation of the Mirzapur detachment, has been carried out on the scale of two inches to the mile, the same as that adopted for the rest of the *zamindári* lands in the Mirzapur district, and it has mainly comprised *taluka* Naugarh where the detached plots of cultivation above referred to are situated, and the hilly part of Chakia. The country mostly is hilly, the ridges ranging from 150 to 600 feet above the valleys, and the elevations of the ridges above sea level ranging from 600 to 1,200 feet. There is also a considerable extent of intricate raviny ground, and in many parts there are very dense forests where preserves for game are maintained by the Maharajah.

157. The third operation on which the detachment has been engaged was in the Government Estate of *pargana* Dudhi to the extreme south of the Mirzapur district, where during the topographical survey which had been executed in recent years, special provision had been made by carrying out additional traversing within village boundaries and by marking all the traverse stations in a permanent manner for a basis for the cadastral survey of the cultivation to be undertaken at a future time, and this cadastral survey in accordance with the requisition of the Government of the North-West Provinces has now been done. The scheme for this operation provided only for the immediate survey of the permanent cultivation, but the *patwáris* of the *pargana* were required to be trained and partially employed under professional supervision, so that they might be capable of measuring the fluctuating cultivation year by year or as might be necessary. Surveys have been made in all of the 186 villages comprised in the *pargana*, and they amount in aggregate area to 41·95 square miles, which is about one-fifteenth of the total area of 646 square miles. The 16-inch sheets, however, on which the surveys have been mapped, numbering 429, have been projected for complete villages showing the boundaries, but without any other interior details except the cultivation.

158. The out-turn of the several descriptions of surveys executed in the Mirzapur district is shown in the following statement:—

District.	Taluka or Pargana.	Cadastral Survey, Scale 16 inches to a mile.			Topographical Survey, Scale 2 inches to a mile.	Remarks.
		Number of villages.	Number of fields.	Area, square miles.	Area, Square miles.	
Mirzapur	Chakia .	471	121,826	134·63	87·32	The number of villages for *taluka* Naugarh includes the number of cultivated plots surveyed as villages. For *pargana* Dudhi the total number of villages is shown, but the survey has included only cultivated lands.
	Naugarh .	131	12,912	72·40	158·39	
	Dudhi .	186	51,586	41·95	...	
	Total .	788	186,324	248·98	245·71	A topographical overlap of 21·95 square miles has also been surveyed in district Shahabad of Bengal.

In addition to the above, the traversing required for the survey of sixty-five cultivated plots in *taluka* Naugarh has also been done during this season, having been left over when the rest of the traversing was done last year. The cadastral maps were tested by 953 linear miles of check surveys, and 58,535 entries in the *khasras* were tested. For the topographical work the checks were chiefly examinations of parts of the plans by a responsible Assistant Surveyor.

159. Tracings on vellum cloth of the 16-inch plans of Chakia and Naugarh have been supplied to the Settlement Officer of the Maharajah of Benares: a question is pending whether the Maharajah will require printed copies of the maps. Of *pargana* Dudhi, a tracing on vellum cloth and a copy on imperial paper has been supplied for each of the cultivated blocks, the paper copy being intended to be used by the *patwáris* for inserting additions to the cultivation. The field sections of the topographical survey of *talukas* Chakia and Naugarh have been sent to the Surveyor-General's Office to be incorporated with other final maps of the standard size series which are being drawn there.

160. The recess office of the party was inspected at Naini Tal during September by the Deputy Surveyor-General in charge of the Revenue Branch, who reports that he was well satisfied with the character of the records that had been executed, as well as with the manner the several officers who had held charge of the party during the season, *viz.*, Lieutenant-Colonel S. H. Cowan,

NORTH WEST PROVINCES SURVEY.

INDEX TO THE SURVEY OPERATIONS IN DISTRICT MIRZAPUR.

No. 4 PARTY.

Photozincographed at the Survey of India Offices, Calcutta.

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1888

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN THE SRINAGAR ESTATE.

No. 4A PARTY.

Major J. R. McCullagh and Mr. H. T. Hanby, had exercised the duties of directing the operations.*

SRINAGAR AND BANAILI JOINT ESTATES, DISTRICTS BHAGALPUR, MONGHYR, PURNEAH, AND MALDAH.

No. 4A Party.

161. The employment of a survey party in this estate, held mainly as the joint property of the Srinagar *zamindár*, who is a Government ward, and of the Banaili Raja, the cadastral survey of which had been directed by the Government of Bengal, was sanctioned by the Government of India in Revenue and Agricultural Department letter No. $\frac{633}{49-10}$, dated 5th December 1887; and the Government of India approved of the scheme of operations proposed by the Government of Bengal for the cadastral survey, to be carried out partly under the supervision of a Settlement Officer and partly under the direction of the officer in charge of the survey party, while the survey party would execute the whole of the traversing. The scheme also provided that efforts should be made to train a local agency for the work of the survey and for the maintenance of the records.

Personnel.

Mr. G. B. Scott, Officiating Deputy Superintendent, 4th grade, in charge from 28th November 1887 to 8th July 1888.
„ W. J. O'Sullivan, Surveyor, 3rd grade, in temporary charge from 9th July 1888.
„ E. F. Berkeley, Assistant Surveyor, 2nd grade.
„ F. B. Powell, Assistant Surveyor, 3rd grade, from 20th December 1887.
6 Sub-Surveyors and others.

Temporary Establishment.

42 Field Surveyors and others.

162. To carry out this survey a special party was organized, being formed mainly from the traverse section of No. 4 Party which was available for transfer from the North-West Provinces; and the preliminary arrangements for the survey were made by the officer in charge of No. 4 Party until Mr. G. B. Scott, Assistant Superintendent, who had been appointed to the charge of the new party, could join after being relieved of a temporary charge he was holding in the Central Provinces. Traversing operations were begun early, about the middle of October, and the cadastral survey followed during December as soon as the necessary traverse plots were ready. Field work was continued until about 1st July, when the office establishments were concentrated at a recess office which had been opened at Monghyr.

163. At the request of the managers of the estate, and in accordance with the wishes of the Director of Land Records, the operations were first undertaken in the parts of the estate which lie in the Bhagalpur district, where, in three *parganas*, the villages of the estate are found to be grouped in compact blocks of fair size, besides scattered villages in two other *parganas*. The traversing and the cadastral survey has been done by the survey party in two of the *parganas* and in the scattered villages, while the compact block of villages in one of the *parganas*—Daphar—was set apart for cadastral survey under the orders of the Settlement Officer, Mr. E. W. Collin, C.S., on traverse plots furnished by the survey party, which has been mentioned as part of the scheme of operations. After Bhagalpur, the operations were undertaken in the Monghyr district, where there is one large block of villages which has been completed both as regards cadastral survey as well as traversing; and finally, the traverse section moved into the Purneah and Maldah districts to prepare the villages in those districts (where they are very much scattered) for cadastral survey during next season. Considerable difficulty was experienced in ascertaining the situations of the detached villages, and there still remain to be traversed 4 villages in the Bhagalpur district, 1 in Monghyr, about 35 in Maldah, and 4 in the Durbhunga district which has not yet been visited. Besides villages the boundaries of which are being traversed on account of the estates holding the whole or the greater part of the lands, the estates possess fields scattered in villages of other estates, but the survey of these outlying fields will not be undertaken by the party.

* Mr. Hanby, who prepared the report in the absence of Colonel Cowan with No. 8 Party, reports highly of the good services of Messrs. Price and Berkeley in charge of sections, and of the assistance rendered by Messrs. Warwick and Johnson.

† Of the permanent native establishment the following sub-surveyors and others are specially mentioned, *viz.*, Mir Asjad Ali, Jamaluddin, Ramjas Misr, Bhowani Persad, Patundin and Jogeshar Bhattaharjee; and the following who hold responsible posts in the temporary establishment, *viz.*, Ganga Pershad, Rahim-udin and Makbul Ahmed.

164. The areas which have been surveyed are shown in the following statement:—

District.	Pargana.	Traverse Survey.		Cadastral Survey.		Remarks.
		Number of villages.	Area. Square miles.	Number of villages.	Area. Square miles.	
Bhagalpur	Daphar*	81	91·16	...	...	*Cadastral survey undertaken by settlement staff.
	Kubkhund	75	83·91	75	83·91	
	Uttarkhund	26	39·48	26	39·48	
	Narsingh Khari	8	22·29	8	22·29	
	Chhai	7	22·33	7	22·33	
Monghyr	Farkia	117	182·11	117	182·11	
	Balia	1	4·94	1	4·94	
Purneah	Tirakharda	63	75·78	...	...	
	Haveli	163	159·76	...	..	
Maldah		70	24·64	...	...	
	Totals	611	706·40	234	355·06	

From the above it will be seen that 296 villages, in area equal to 260·18 square miles, have been traversed in districts Purneah and Maldah for cadastral survey next season. The detail survey included 346,248 fields, the average size of which taken on the entire area is 0·66 of an acre, but if taken on the cultivated area it is less than 0·4 of an acre, the former average being caused by large uncultivated portions of villages in district Monghyr.

165. In the traversing, each block of villages and each detached village has been made a separate survey, the scattered condition of the lands of the estates having rendered any continuous traversing quite unsuitable. The relative positions of the villages as shown on the index maps are therefore due to the positions they are found to occupy on the maps of the former village surveys of the several districts. But azimuths have been observed to regulate the projection of the maps of the detached villages as well as of the blocks, so that the maps of the estates' villages will be in accord with any complete surveys of the districts that may hereafter be undertaken.

166. The stone marks which have been embedded at all tri-junctions of village boundaries and at selected traverse stations in districts Bhagalpur and Monghyr will serve the purpose of connection with future surveys of the districts, as well as for the permanent definition of the village boundaries which is their first object; and these marks now put down for the estates' villages are, it may be mentioned, the only permanent marks existing in the several districts, the permanent demarcation of the boundaries having formed no part of the former village surveys. In Purneah and Maldah, the tri-junction points and theodolite traverse stations have been, for the present marked in a temporary manner only, pending the adjustment of disputed boundaries, considerable inconvenience having been experienced in Monghyr through the removal of permanent marks wherever a boundary was disputed.

167. Under the original plan of operations enjoined by the Government of Bengal for the cadastral survey and for the writing of the record of rights to be carried out by village officials, at first a staff of professional *amins* sufficient only for training purposes was brought with the detachment from the North-West Provinces, and the managers of the estates were asked to collect the *patwáris* to be instructed in cadastral surveying; but the managers immediately represented that the *patwáris*, whose duties as collectors of revenue over considerable tracts are various, could not be spared for the long periods requisite for the survey work, and the scheme to employ them as surveyors had to be abandoned. An attempt was then made to form a surveying establishment from natives of the Bhagalpur and Monghyr districts, and about 50 men were obtained on the promise of a subsistence allowance being given them during training. Of these,

barely half the number proved efficient as surveyors, and although a slight progress was made, it soon became evident that local agency could not be depended upon for the accomplishment of an area at all commensurate with the cost of the supervising establishment or for the completion of the area contemplated for the season, and recourse had to be made to the professional *amins* of the North-West Provinces. Fortunately, survey work was closing in two districts in those provinces, and squads of *amins* were obtained on transfer from time to time, till at last about 100 men were employed including those locally entertained. A satisfactory monthly rate of progress was thus established. In December, the out-turn was only 3 square miles; in January, 35, in February, 37, in March, 59, and in April over 100 square miles were surveyed.

168. Although the *patwáris* of the estates were found to be not available for survey work on account of their many other duties, besides being in insufficient numbers, their training as surveyors has not been overlooked, and arrangements were made for their instruction at several convenient centres during July and August, when it was ascertained they would have most leisure. Thus, 19 joined the training class at Monghyr on 5th August, 10 at Nowhatta, in the Bhagalpur district, on 10th September, and 20 at Purneah on 19th August. Some of the Purneah men, it is said, may perhaps be available for survey work next season.

Mr. Scott reports on the *patwáris* generally that—

'Most of them took an intelligent interest in the work while in progress, and the greater number are, I should think, quite capable of making corrections and additions to the maps indicating future alterations, although unable to make complete original surveys of whole villages."

169. In the cadastral survey, the *kiáris* (or subdivisions of "fields" in rice-growing tracts) have been mapped, as without them, on account of the ridges defining them being of so permanent a character, the maps would have been very imperfect representations of the features of the country; but the boundaries of the "field" (*i. e.*, the plots in which tenants have separate rights) have been distinguished by different drawing, and the areas of the "fields" only have been calculated and recorded in the village papers. The calculation of the areas was done by the *amins* on the field and at once communicated to the tenants, and this system of calculating the areas during the survey, instead of leaving them to be done afterwards in office, is said by Mr. Scott "to have done more to impress the tenants with the actual value of the work than anything else, especially as, whenever they complained to the European officers visiting the villages that any fields had been wrongly calculated, these were at once re-measured in their presence. The village *laggis* were in constant demand and used freely to test the *amins'* statements."

170. The *laggi*, on which local measurements are based, was found to vary in each *pargana* and district, and is a subject of dispute between landlord and tenant. The length of the *laggi* did not in any way affect the cadastral survey measurements, as these were all made with Gunter's chains; but, as the field areas were required to be recorded in *bighas*, *kattahs* and *dhúrs* (not in acres and decimals as obtainable from the Gunter's chains), it was necessary to adopt a *laggi* of a fixed length in order to establish an uniform standard of square measure for use throughout all the villages of the estates. A standard *laggi* of 6½ *haths* with the *hath* of 18 inches was therefore adopted for the calculation of the field areas, and when the *laggi* question is disposed of during the settlement, proportionate corrections will have to be made where another measure is allowed.

171. The record writing was done in Kaithi-Hindi by the *amins* or by young *kaists* of the country who accompanied the *amins*. The entries were those of tenant, crop and soil, those for rent and tenure being left to be recorded by the settlement staff. Mr. Scott mentions the following circumstances connected with the record writing:—

"Some peculiar practices, to call them nothing stronger, came to light in the course of these inquiries. In several villages where *Brahmin* tenants predominated, these had taken up separate holdings at different times, registering all but the original holding under fictitious names. One reason given for this practice was that it saved confusion in rents and tenures, but it also was used to evade seizures for debt and probably to avoid payment of rent in many cases. Sub-tenants of low caste frequently cultivated these lands paying half produce to the actual holder. While the fictitious holder was often

entered in the *patwári's* books as a defaulter. The *patwáris* at first endeavoured to hide these facts, but generally ended by giving the names of the actual tenants. This practice is carried to such an extent that in one village of 196 acres there were 47 fictitious tenants' names in the *patwari's* books. The discovery of the practice rather alarmed the tenants at first, but after assessment commenced they were quick to discover the advantages of a correct record of areas and holdings as a future safeguard of their rights against the opposing claims of the landlords."

172. The vernacular records and the tracings of the maps of the villages were all made over to the settlement officer before the end of the recess season, except those of six villages which, though ready, were kept back for special reasons.

173. The office of the party was inspected at Monghyr during July by the Deputy Surveyor-General in charge of the Revenue Branch, who states that the records were found to be quite satisfactory, and who reports Mr. Scott's management of the party to have been very able and most energetic. While Mr. Scott was absent on three months' leave during the recess season, Mr. O'Sullivan carried on the office duties to the Deputy Surveyor-General's entire satisfaction.*

GORAKHPUR, TARAI AND JHANSI DISTRICTS, NORTH-WEST PROVINCES.

No. 5 Party.

174. This party, after closing its recess office at Naini Tal on 2nd October 1887, resumed field operations in the Gorakhpur district on 1st November, having for its programme in that district the completion of the cadastral survey, in accordance with the special requirements of the expiring settlement as mentioned in paragraph 154 of last year's report. The survey was practically completed by 30th May, excepting that of the *mohullas* of Gorakhpur city, the requisition for which was received late in the season. On the withdrawal of the main office establishment to Naini Tal during May, the usual vernacular office was opened at Gorakhpur and placed in charge of Mr. W. V. Skilling, Assistant Surveyor, who also was employed in supervising the completion of the city *mohullas*.

Personnel.

Lieutenant-Colonel J. E. Sandeman, S.C., Deputy Superintendent, 2nd grade, in charge.
Mr. E. G. Little, Surveyor, 3rd grade, in temporary charge up to 13th October 1887.
„ T. F. Freeman, Assistant Surveyor, 1st grade.
„ A. W. Smart, Do. Do., 1st grade.
„ N. Bedford, Do. Do., 2nd grade.
„ W. V. Skilling, Do. Do., 3rd grade.
„ F. B. Powell, Do. Do., 3rd grade, up to 30th November 1887.
„ J. H. Murphy, Assistant Surveyor, 3rd grade, from 1st November 1887.
23 Sub-Surveyors and others.

Temporary Establishment.

562 Field Surveyors and others.

Tarai Detachment.

Mr. J. Murphy, Assistant Surveyor, 1st grade.
62 *Patwáris* and others.

175. When the main body of the party proceeded to Gorakhpur in November, a detachment was again left to continue cadastral operations in the Tarai district where an additional area had been assigned for survey under North-West Provinces Government Order No. $\frac{738}{1.8A}$, dated 4th June 1887. The detachment took the field on 28th November 1887 and was forced to close the operations abruptly in the beginning of May on account of a sudden and very severe outbreak of fever by which half the men, including the Assistant Surveyor in charge, were incapacitated for further work.

176. Lastly, the traverse section of the party, after completing the traversing of the Gorakhpur district, proceeded on the 11th January 1888 to the Jhansi district to undertake traversing operations there in accordance with the sanction to a scheme for the cadastral survey of the district through the agency of *patwáris* accorded by Government of India, Revenue and Agricultural Department, letter No. $\frac{413}{99\text{-}3S.}$, dated 29th July 1887.

177. In the Gorakhpur district, in *parganas* Haveli, Maharájganj, and Binayakpur, a novel feature was met with in an extensive tract of rice cultivation where the "fields" were (as is usual for rice lands) sub-divided into many *kiáris* for cultivating purposes. To have omitted these *kiáris* entirely would have rendered the maps very imperfect representations of the intricate character of the country,

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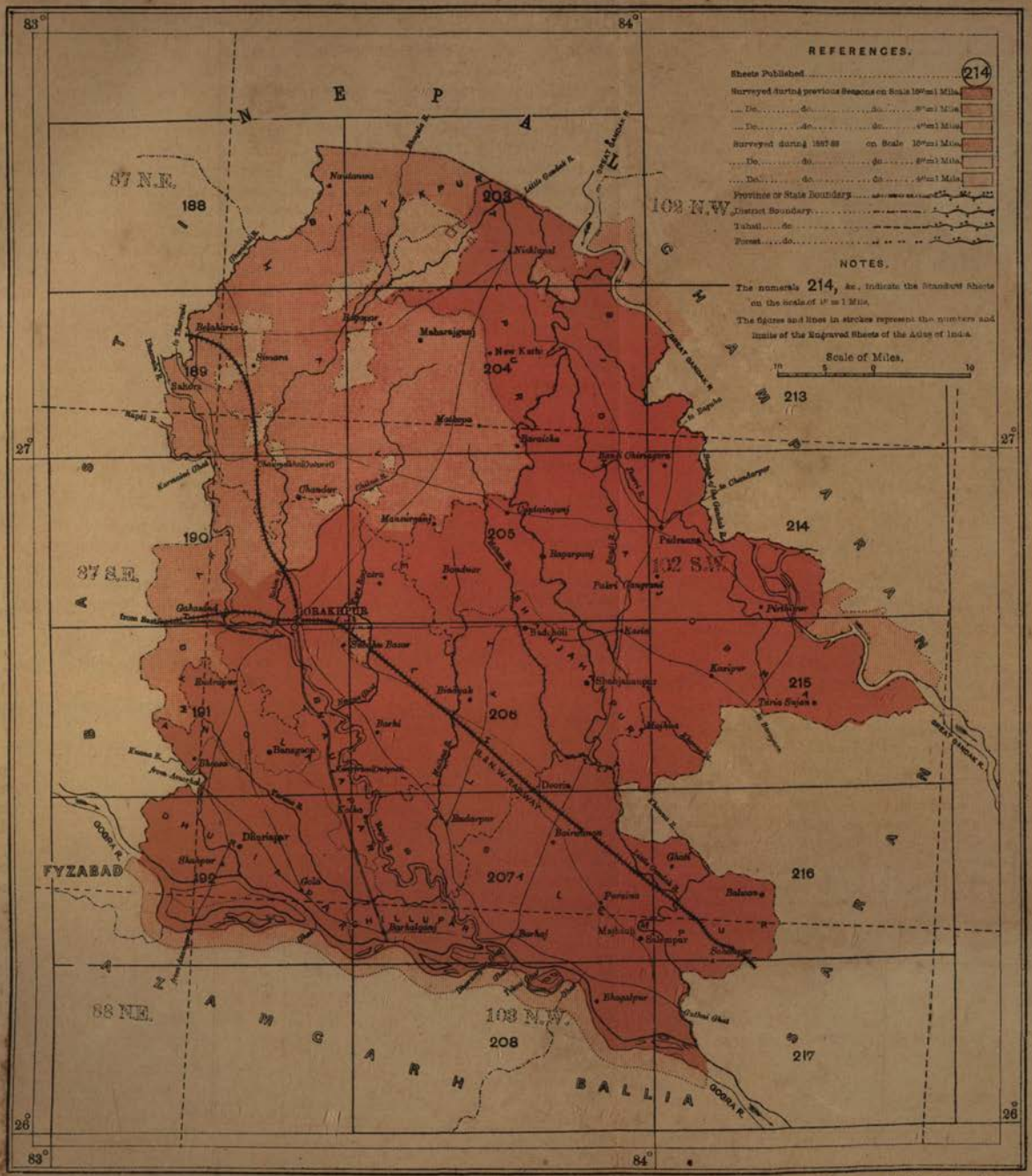
* Mr. Scott reports very highly on the services rendered by Mr. W. J. O'Sullivan, first in charge of the traverse section and afterwards in charge of the whole office for three months during the recess season.
Messrs. E. F. Berkeley and F. B. Powell are also commended for efficient work throughout the season.
Of the native establishment the following are specially mentioned for good work, *viz.*, computers Kanhia Lall and Gauri-Shankar, and sub-surveyors Enayet Ulla and Gofur Bakhsh.

N. W. PROVINCES SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DIST. GORAKHPUR.

No. 5 PARTY.



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Published under the direction of Colonel H. R. Thuillier, R. E., *Surveyor General of India.*

Survey of India Offices. Calcutta, December.

1888

but to have surveyed and numbered them all would have largely increased both field and office work, besides furnishing village records too voluminous for the *patwáris* to carry out the duties they have to perform annually in connection with them; therefore, it was decided by the Settlement Officer that three or four *kiáris* should be grouped so as to form sub-divisions of the "fields" about the size of half an acre.

178. With regard to the survey of the city of Gorakhpur, it had been expected that the operations might have been restricted, according to the requirements of the settlement, to the cultivated area, and to the area which had been under cultivation at the time of the last settlement which is still assessable under Board's rules, while the remaining details of houses and streets within the city would have been taken by transfer from a map which had been recently prepared under the direction of the Collector. But the Collector's map on being tested was found to be unsuitable for incorporation with the present survey; besides, the plots required to be surveyed for settlement purposes came to be more numerous than had been anticipated, and on the latter count it was decided by the Settlement Officer that a complete survey of the city was a necessary part of the present settlement survey operations. The scale of 24 inches to a mile was adopted as being suitable for showing the details required for the settlement, while being also the scale of the Collector's municipal map, a direct comparison between the two surveys is thus facilitated, but the scale is insufficient to represent the houses otherwise than in blocks as divided by streets and lanes, and the ordinary character of a city survey in which each house is separately mapped and numbered could not be maintained, as the municipality refused to bear the additional expense of a survey on an increased scale. Separate maps have been prepared for each of the sixty-eight *mohullas* into which the city is divided, the same as at the last settlement.

179. The survey of fourteen reserved forests, situated in four *parganas*, has been carried out on the scale of 8 inches to the mile, which was the scale approved by the Forest Department when the work was begun by two forests being surveyed last season.

180. In accordance with the usual practice, which has the sanction of the Government of India, a small area of *diwara* land consisting of a strip of villages has been surveyed in district Chumparun of Bengal where the common boundary of that district with Gorakhpur falls in the bed of the Gandak river.

181. The following statement shows the areas of the different descriptions of survey:—

District.	Tahsil.	Description and scale of survey.	Number of villages.	Area in square miles.
Gorakhpur	Gorakhpur	Cadastral survey with usual village records: scale, 16 inches to a mile.	129	78·13
	Maharájganj	...	1,426	983·32
	Gorakhpur City	As above; scale, 24 inches to a mile.	68*	4·85
	Total of Cadastral Survey		1,623	1,066·30
	Gorakhpur	Forest survey; scale, 8 inches to a mile.	2	4·67
	Maharajganj	...	12	136·64
	Total of Forest Survey		14†	141·31
Chumparun (Bengal)		Gandak Riverain Survey; scale, 4 inches to a mile.	...	24·47
	GRAND TOTAL		1,637	1,232·08

* Mohullas. † Forests.

In the cadastral area there are 1,211,446 fields having an average size of 0·56 of an acre. Besides the cadastral survey effected in the area shown in the above statement, the traversing was likewise done of 465·7 square miles which had been left over from the previous season.

182. The permanent demarcation of village boundaries remained to be done only for the area left over for traverse survey, and it has been completed in the usual manner, the tri-junction points having been marked by the Settlement staff previous to the survey, and other intermediate points where traverse stations have been fixed having been marked during the survey. Statements which have been furnished to the Collector show that a total sum of ₹5,151 is recoverable from the *zamindárs* of the Gorakhpur and Maharajganj *tahsils* for the cost of the station marks which also serve as boundary marks. There were 1,003 cases of disputed boundaries, all of which have been settled either by the adjudication of the Settlement staff or by relaying the boundaries according to the maps of the former survey. Special pillars have been built along the line of the Gorakhpur-Saran boundary where the disputes had been settled by the Settlement Officer of Gorakhpur acting in concert with an officer deputed from Bengal, as mentioned at paragraph 157 of last report.

183. The cadastral survey has been tested by 4,151 linear miles of check surveys, of which 2,483 miles were measured by inspectors of squads during the survey, and 1,668 miles (or 1·57 linear mile per square mile of survey) were measured by European officers or specially deputed inspectors after the survey. The checks on the records were 13,941 numbers tested by European officers and 356,149 by inspectors. The angular work of the traverses has been regulated by observations at sixteen stations, and the chain measurements of the main circuits have been corrected by co-ordinate values of Great Trigonometrical Survey stations, to which there has been one new connection.

184. The season's out-turn of cadastral survey has been mapped on 1,802 sheets, which cannot be finally disposed of or the order given for them to be printed until the settlement has been effected. In the meantime, the sheets have been sent to Calcutta to be used for the drawing of the 2-inch maps, which is being proceeded with in the Surveyor-General's Office on projections furnished by No. 5 Party. A series of sheets on the 4-inch scale of the riverain area where the Gandak forms the boundary of the district is being drawn in the party office. Colonel Sandeman has undertaken the preparation of a soil map for the whole of the Gorakhpur district, also of a series of maps to illustrate statistics of various kinds which have been tabulated during the survey, *viz.*, of irrigated land, of different crops, of different castes, &c.

185. During the year, 1,075 cadastral maps have been sold to Gorakhpur *zamindárs*, bringing the total number of these maps that have been sold to 25th August 1888 up to 2,634 for which the amount received has been ₹987-12-0. The agency for the sale of the maps has been transferred from the survey party to the Collector's office.

186. Messrs. Hose, Stewart Wilson, Cooke, Ramautar Pande, Jowala Pershad, Syed Mahommed Ali, and Syed Habibulla of the Civil Service have been passed through the usual course of survey instruction during the field season.

187. Since last report and up to 30th September 1888, 27 *kanungos* and 546 *patwáris* have passed through the survey school at Gorakhpur, making a total number of 46 *kanungos* and 726 *patwáris* (including 61 candidate *patwáris*), who have passed since the school was opened on 1st January 1887. Besides instruction in survey matters, the duties of *patwáris* as laid down in Part III, Board's Circulars, have latterly formed part of the school course. Monthly examinations of the school were conducted during the field season by Colonel Sandeman and during the recess by Mr. W. V. Skilling who was left on duty at Gorakhpur.

188. Colonel Sandeman expresses his acknowledgments to the civil officers of the Gorakhpur district in the following terms:—

"Now that we have completed the district, I beg once again to acknowlege the cordial co-operation of Mr. A. W. Cruickshank, Settlement Officer, and of the settlement staff, and of Mr. D. Roberts, Collector of the district. We have unfailingly received every assistance that it was possible for them to give us."

189. The cadastral survey of Gorakhpur district has now been completed, having been begun in season 1883-84 and having thus occupied the entire estab-

NORTH WEST PROVINCES SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT TARAI.

No. 5 PARTY.

REFERENCES.

Sheets published 84

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Do. 1896-97 ..... on Scale 16" = 1 Mile. .....

Do. 1897-98 ..... on Scale 16" = 1 Mile. ..... Through Patwari Agency

Do. do. ..... on Scale 4" = 1 Mile .....

Province or State Boundary .....

District ..... do. .....

Tahsil ..... do. .....

NOTES.

The numerals, 84, &c., indicate the Standard Sheets on the Scale of 1" = 1 Mile.

The figures and lines in circles represent the numbers and limits of the Engraved Sheets of the Atlas of India.

Scale of Miles.

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Photozincographed at the Survey of India Office, Calcutta.

lishment of No. 5 Party for five seasons, as is shown in the following statement, giving the particulars of the work, to which the final account showing the cost and cost-rates cannot yet be added, as is usual, a further expenditure for the drawing and compilation of maps having to be included:—

Particulars of the Cadastral Survey of district Gorakhpur.

Season of survey.	Number of villages.	Number of fields.	Area in square miles.	Number of cadastral sheets.	Remarks.
1883-84	1,883	891,996	744·31	1,500	The operations of the Survey have included the preparation of the several village papers constituting the record of rights and nine statistical statements for each *tappa*.
1884-85	2,183	899,793	747·37	1,745	
1885-86	1,251	894,028	820·09	1,447	
1886-87	1,685	930,427	1,047·83	1,976	
1887-88	1,555	1,192,076	1,061·45	1,802	
Total of survey in scale of 16 inches to a mile	8,557	4,808,320	4,421·05	8,470	
Survey of Gorakhpur City, scale 24 inches to a mile			4·85	42	
Survey of Forest Reserves, scale 8 inches to a mile			169·78	54	
GRAND TOTAL			4,595·68	8,566	

190. The work of the season, which in the first instance was assigned to the detachment detailed for the Tarai district, was the cadastral survey of the cultivated lands in *parganas* Bilhari and Kilpuri, and to this the topographical survey of the Fuel and Fodder Reserves in the Bilhari *pargana* was subsequently added. The district *patwáris* have again been employed as surveyors in place of professional *amins*, and this season the men have worked much more willingly than they did last season. They have also been taught to survey the topography in the Fuel and Fodder Reserves as well as the details of the fields in the cultivated lands, which was all they did last year; and one *patwári* has been employed as a traverse surveyor.

Personnel.

Mr. J. Murphy, Assistant Surveyor, 1st grade.
1 Computer, and 1 Sub-Surveyor.
Temporary Establishment.
6 Computers, and 4 Inspectors.
50 *Patwáris.*

191. The out-turn of the season has been as below :—

Parganas.	Description and scale of survey.	Number of Villages.	Area.		Remarks.
			Acres.	Square miles.	
Bilhari	Cadastral; 16 inches to a mile	87	77,598·82	121·25	In the cultivated area there are 50,581 fields.
Kilpuri		28	23,678·99	37·00	
Total of Cadastral Survey.		115	101,277·81	158·25	
Bilhari	Topographical; 4 inches to a mile	23*	42,328·64	66·13	* Separate Fuel and Fodder Reserves.
TOTAL OUT-TURN		138	143,606·45	224·38	

The traversing of the above areas has been done as well as the detail survey, and there is an area of 45 square miles of traverse survey in advance. The names of the cultivators were not entered in the *khasras*, having been left to be written in at the harvest next following the completion of the survey.

192. Theodolite stations are marked by stones embedded at the tri-junctions of boundaries and at other selected points along the boundaries, the rest of the stations being marked by pottery cylinders. Many of the stones were obtained from the Sarda river and are heavy substantial marks. There were forty-one boundary disputes in the season's work, which were settled in accordance with maps prepared by the Assistant Surveyor, showing the boundaries of the former village survey.

193. As was the case last year, a larger amount of check survey was found to be required to ensure good work from the *patwáris* than would have been necessary had the surveyors been professional *amins*, but with close supervision and careful check, very accurate work was obtained. The Tharu (aborigines) *patwáris* are said to have distinguished themselves in having become excellent surveyors after a very short course of training. *Patwáris* were again only partially employed for office duties during the recess, not being available in sufficient numbers.

194. The cadastral survey has been mapped on two hundred and thirty-one sheets on the 16-inch scale, and the survey of the Fuel and Fodder Reserves on eight sheets on the 4-inch scale. For the general maps of the Tarai, the 4-inch scale has been abandoned in favour of the 2-inch scale, the same as is now adopted for all other districts which are surveyed cadastrally; and the parts of the district which have already been mapped on the 4-inch scale will be re-drawn on a complete series of 2-inch maps.

195. A further grant has been sanctioned by North-West Provinces Government Order No. $\frac{1207}{1-8A}$, dated 16th August 1888, for the continuance of the cadastral and topographical survey of the Tarai district, which it is expected will allow of the entire district being completed next season, the areas for survey being understood to be 71 square miles of cultivated lands for cadastral survey and 200 square miles of Fuel and Fodder Reserves for topographical survey. Besides the above, the cadastral survey of about 70 square miles of cultivated land in the Bhábar district, adjoining the Tarai district, has recently been sanctioned and a grant allowed by North-West Provinces Government Order No. $\frac{1510}{1444-}$, dated 16th October 1888. The Tarai detachment will have the additional employment of this new survey during next season.

196. A scheme, submitted by Colonel Sandeman, for the cadastral survey with revision of records of districts in the North-West Provinces to be effected at a very favourable cost, entirely through the agency of *patwáris*, having received the approval of the Government of India in Revenue and Agricultural Department letter No. $\frac{413}{99-38.}$, dated 29th July 1887, the district of Jhansi was recommended by the Board of Revenue, North-West Provinces, to be brought under the operation of the scheme. But before according sanction to this recommendation, the Government of the North-West Provinces required a further report on the worth of the existing field maps, and orders had not been issued when the traverse section of the party, having completed its work in the Gorakhpur district, was ready to move to Jhansi. The absence of a complete report on the field maps also precluded the issue of orders for the survey training of the *patwáris*, which, under the scheme referred to above, Colonel Sandeman wished to carry out during the same season as the traversing. When the traverse section had been kept a month waiting for orders, it was permitted to proceed to Jhansi where work was begun on 11th January 1888. The training of the *patwáris* was postponed under the orders of the Government of the North-West Provinces until the following season.

197. Final orders for the Jhansi survey are contained in Government of North-West Provinces Order No. $\frac{888}{1-505}$, dated 29th June 1888, in which sanction is given to the reconstruction of maps and revision of records through the agency of *patwáris* on the principles of Colonel Sandeman's scheme already mentioned. According to the scheme, the *patwáris* are to do the survey and records, each of his own circle, in two years, and the cost is estimated at ₹40 per square mile, provided the charges for supervision can be reduced by similar operations being

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No. 5 PARTY.

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January 1889

carried on over two districts simultaneously. As yet no second district has been assigned for cadastral survey and there is a prospect of the estimate being exceeded accordingly.

198. The traversing has been carried on over the entire extent of the Jhansi district in order that at least one plot might be available in each *patwári's* circle for the cadastral survey to be begun early throughout the district. None of the four *parganas* into which the district is divided has therefore been completely surveyed, and the following statement represents the summation of the areas of the villages which have been surveyed in each of the *parganas*:—

Pargana Mau	.	214	square miles.
„ Garotha	.	187	„ „
„ Moth	.	205	„ „
„ Jhansi	.	219	„ „
Outlying parts of Native States	.	55	„ „
TOTAL		880	„ „

In the above there are 348 villages, and there remain for survey 382 villages with an estimated area of 870 square miles which includes an area of 45 square miles of intermixed portions of Native States. The area of the Gursarai estate, situated within the Jhansi district and held under a peculiar tenure, the cadastral survey of which has been recommended by the Director of Land Records, may have to be added to the above. There are also 171 plots of forest reserves with a total area of 39 square miles scattered over the district.

199. The traverse stations have been marked with stones provided locally by the village *zamindárs*, who have also assisted in the embedding of the stones and have thus been relieved from any further contribution on account of the cost of permanent marks at stations. The traverse survey has been regulated by seventy-four sets of observations for azimuth and by connections on eight stations of the Great Trigonometrical Survey.

200. At the request of the Board of Revenue, Colonel Sandeman has drawn up a set of revised rules under Act XIX for survey and recording of rights up to the point when the formal verification prior to assessment would be undertaken by the Settlement staff.

201. The recess office of the party was inspected at Naini Tal during September by the Deputy Surveyor-General in charge of Revenue Branch, who reports on the high state of efficiency to which Colonel Sandeman has raised his establishment, thus rendering it possible for an unusually large out-turn of excellent work to be accomplished and testifying to Colonel Sandeman's energy and enterprise which lead him to be constantly devising new measures of improvement in survey procedure. The greater part of this highly efficient establishment which has been engaged on the cadastral surveys of districts Muttra, Banda, Mirzapur, and lastly of Gorakhpur, where it has been trained in the complete duties of record-writing, has now been dispersed, the services of the men not being required for the Jhansi district on account of the new system of employing the *patwáris* as surveyors.*

* Colonel Sandeman reports on the services of the officers serving under him in the following terms:—

"It is only just that I should bring prominently to notice the services of Messrs. Little, Freeman and Smart, who have been in charge of sections, the two former during five seasons and the latter during four seasons. I cannot speak too highly of the manner in which they have performed their arduous duties, and our success, such as it has been, is greatly due to their exertions. Having witnessed the unflagging manner in which they have worked throughout, I cannot but regret the stagnation of promotion in the Department, which debars hard-working and intelligent officers, such as they are, from ordinary advancement. Each one of them is a very deserving officer. I have every reason to be satisfied also with the services of Messrs. Bedford, Skilling and J. H. Murphy, who all, especially Mr. Bedford, promise to turn out efficient surveyors after more experience.

"The following members of the native establishment are deserving of notice on account of their good work:—

"Puran Chand, computer and sub-surveyor; Badri Pershad, Babu Ram and Har Sahai, writers, and Amanat Hosein and Jai Narain, who have been appointed *Sadr Kanungos* of Banda and Sitapur respectively.

"Shib Sahai in charge of *patwári* school, Bishambar Shai, Kashi Persad, Abdul Hamid, Elahi Baksh, and Babu Ram, who has been appointed *patwári* school teacher at Shahjehanpur."

Mr. J. Murphy has managed the work, which is of a most difficult nature in a trying climate, greatly to my satisfaction, but he will do better even yet in the light of his further experience.

Mr. Murphy reports well of his native staff, especially of Bhajan Lall, computer, Bala Pershad, draftsman, and Gunga Pershad, sub-surveyor.

NOWGONG AND SIBSAGAR DISTRICTS, ASSAM.

No. 6 Party.

202. This party left recess-quarters at Shillong on 20th October 1887, and proceeded to the field in two sections, the first section to undertake the cadastral survey of the part of the Nowgong district where traversing had been done during the previous season, and the second section to begin the traverse survey of an allotted tract in the Sibsagar district. Some traverse surveyors were also taken to the Nowgong district to complete the traversing there and to extend the operations to an additional tract assigned for survey in that district. Field operations were begun on 10th November and were continued up to 7th May 1888, when the office establishment returned to Shillong.

Personnel.

Mr. E. C. Barrett, Officiating Deputy Superintendent, 3rd grade, in charge.
Mr. J. H. O'Donel, Surveyor, 4th grade.
„ J. Connor, „ „ „
„ M. Gastaud, Assistant Surveyor, 2nd grade.
„ J. Smith, „ „ „ „
23 Sub-Surveyors and others.

Temporary Establishment.

192 Field Surveyors and others.

203. In accordance with a plan which was mentioned at paragraph 178 of last year's report, village headmen (*mandals*) of the Nowgong district have this season been employed as cadastral surveyors in substitution for a certain number of the Hindustani and Bengali *amins* through whom the cadastral survey in Kámrúp and Darrang has been carried on during four seasons. The *mandals* had previously received instruction in the district survey school, but it was necessary to give them a further training of five weeks at the beginning of the field season, and out of 88 men placed at Mr. Barrett's disposal, 49 were found to be suitable for employment on the survey. The progress of the men was naturally slow at first and constant encouragement and supervision were necessary; but as the men acquired confidence, their returns of work rose in a remarkable way from a daily average of 4·2 acres in November, performed with the help of Inspectors, to 17·3 acres in April, without assistance. The *mandals* drew their usual monthly salaries ranging from ₹6 to ₹10, and they were paid remuneration for survey work according to the areas they surveyed at one-third of the contract rates paid to imported *amins*. Although the average daily out-turn of each of the *mandals* was only about one-half of the average out-turn of each of the imported men, the plan of employing *mandals* as surveyors in Nowgong has been most successful, and it will be continued in Sibsagar, some of the *mandals* of which district having been already trained during the progress of the Nowgong survey, while arrangements have been made for the training of others at the beginning of next field season.

204. The cadastral survey operations have been the same as in districts Kámrúp and Darrang, the maps being on the scale of 16 inches to a mile and the *khasra* being of the same simple character, showing (on account of the tenure being *raiyatwári*) little beyond the names of the tenants and the classes of soil of the fields. During the traverse survey, the *mauzahs*, which in Assam correspond to the *parganas* of Upper India, have been for the first time sub-divided into villages of a size convenient for revenue administration. In this sub-division of the *mauzahs*, existing boundaries of waste-land grants, *lakhiráj* and *nisf-khiráj* estates have been utilized as far as possible, and the average area of the new villages is about 750 acres.

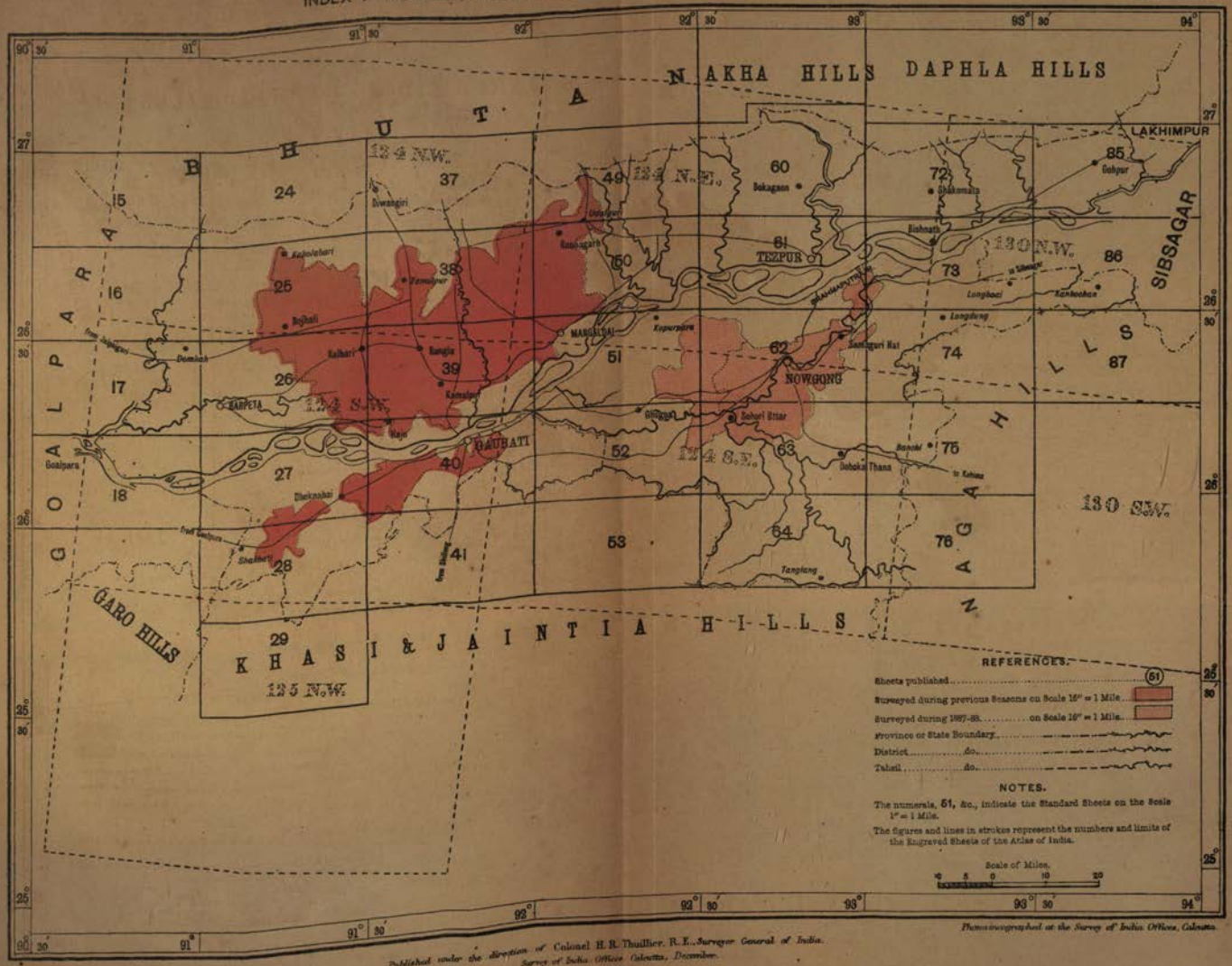
205. The following statement shows the out-turn of the season:—

Districts.	Traverse Survey.			Cadastral Survey.			Remarks.
	Number of mauzahs.	Number of villages.	Area in square miles.	Number of mauzahs.	Number of villages.	Area in square miles.	
Nowgong .	9	170	202·09	25	587	586·59	Parts of 9 *mauzahs* of Nowgong where there is little permanent cultivation have been excluded from the survey.
Sibsagar .	22	342	386·25	...		...	
Total .	31	512	588·34	25	587	586·59	

ASSAM SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTS. KAMRUP, DARRANG, & NOWGONG.

No. 6 PARTY.



REFERENCES.

Sheets published ..... (51)

Surveyed during previous Seasons on Scale 16" = 1 Mile.

Surveyed during 1887-88 ..... on Scale 16" = 1 Mile.

Province or State Boundary.....

District ..... do.....

Tahsil ..... do.....

NOTES.

The numerals, 51, &c., indicate the Standard Sheets on the Scale 1" = 1 Mile.

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Survey of India Offices Calcutta, December.
1888

ASSAM SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DIST. SIBSAGAR.

No. 6 PARTY.

Mod. No. 628, S. I. O.—1-3-69.—750

Photo., S. I. O., Calcutta.

206. Testing procedure was the same as in previous seasons. The check lines measured by the European surveyors and native Inspectors averaged $3\frac{1}{2}$ linear miles for each square mile of cadastral survey, and 10 per cent. of the *khasra* entries were tested by the same officers in the presence of the tenants. Supervision over the *khasra* entries was also exercised by Settlement Sub-Deputy Collectors and *munsarims*, who were associated with the survey staff for this purpose. The traverse survey was checked and regulated by 29 observations for azimuth and by connections on 8 stations of the Great Trigonometrical Survey. Tracings of the cadastral maps, of which there are 752, and the original *khasras* of the 587 villages with the areas of fields entered were furnished to the Settlement Officer before the end of the year.

207. The only traverse stations which have been permanently marked are those at the tri-junction points of village boundaries, where large stone prisms have been embedded; but the other stations have been in a manner permanently fixed by trees (branches of the *semal*) being planted at an uniform distance, 5 feet north of all of them. This expedient of marking the stations inexpensively is said to have been fairly successful as regards the trees which were planted last year, about half the number of the branches that had been put down having been found on examination to have taken root. Those that had failed were re-planted this year.

208. In accordance with the established procedure, eight revision squads, each consisting of a survey *amin* and a *munsarim* of the settlement staff, were sent early in November to district Darrang to enquire into the objections which had been lodged by *pottadárs*, against the delimitation of their holdings by the survey during the previous season. All the inquiries were completed by 30th January, and the cadastral maps, which had been kept back pending the revisions that might be required, were all sent to Calcutta to be printed before the end of the field season.

209. The Chief Commissioner of Assam, Mr. D. Fitzpatrick, C.S.I., inspected the office of the party at Shillong on the 19th September.

210. Mr. Barrett writes as follows concerning the help he received from Civil Officers:—

"Excellent arrangements were made for the furtherance of survey operations by Mr. Knox Wight, Deputy Commissioner of Sibsagar, and by Mr. McLeod, Deputy Commissioner of Nowgong. It is not too much to say that but for the effectual way in which Mr. McLeod repressed the tendency of the *raiyats* to obstruct the field surveyors during the early months of the survey, the out-turn of work would have been much smaller than it is.

"The Settlement Officer, Rai Sarat Chunder Banerjee Bahadur, as usual, co-operated most cordially with the survey throughout the year."

211. The recess office of the party at Shillong was inspected by the Deputy Surveyor-General in charge of the Revenue Branch during June. The state of the records was found to be very satisfactory; and the Deputy Surveyor-General reports highly of Mr. Barrett's management of the party and of his constant endeavours to conduct the operations as best suited for the requirements of the Assam Province.*

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* Mr. Barrett reports on the European officers of the party and of the native establishment as follows:—

"Mr. O'Donel held charge of the cadastral section and brought up the largely increased work that devolved on him owing to the transfer of one of the officers, in a manner highly creditable to him. Mr. Connor held charge of the traverse section and has brought the computations well up to date. Messrs. Gastaud and Smith worked hard and well throughout the field and recess.

The members of the native establishment, both permanent and temporary, gave entire satisfaction. The following are deserving of special mention:—Sub-Surveyors Mohan Singh, Janardhan Rao, Sakhawat Hossein, Khurshed Hossein, Khairuddin and Rajabally; computer Ganga Ram; draftsman Golam Hyder Khan; writer Andhur Chunder Ghose; and temporary employés Jhuni Lal, Harack Narain, Kedarnath, Balabhadria, and Bahadur Singh."

BASSEIN AND THONGWA DISTRICTS, LOWER BURMA.

No. 7 Party.

212. This party, half of which had been employed during the previous season in the Akyab district, has this season been concentrated for cadastral survey in the conterminous districts of Bassein and Thongwa. The traverse section moved out from recess quarters at Rangoon on 1st November 1887, and continued in the field until 24th May 1888. The two cadastral sections followed on 1st December and closed work on 15th May.

Personnel.

Mr. F. W. Kelly, Officiating Deputy Superintendent, 4th grade, in charge.
Mr. H. R. Littlewood, Surveyor, 2nd grade.
„ J. A Barker, Surveyor, 4th grade, up to 30th November 1887.
Mr. G. W. Jarbo, Officiating Surveyor, 4th grade.
Mr. J. S. Swiney, Assistant Surveyor, 1st grade.
„ P. Beechey, ditto, 2nd grade.
„ J. A. T. Haddock, ditto, 3rd grade, from 26th November 1887.
20 Sub-Surveyors and others.

Temporary Establishment.

120 Field Surveyors and others.

213. In the Bassein district the Pulu circle, which had been traversed the previous season, has now been cadastrally surveyed, and the Kawet circle subsequently assigned for survey has first been traversed and then surveyed cadastrally. A topographical survey on the 2-inch scale has been made of a small hilly tract within the Myaungmya circle surveyed cadastrally last season, and the whole of the area in the Bassein district which has been assigned for survey has thus been completed.

In the Thongwa district, the cadastral survey comprised the whole of the assigned area in the Shwelaung township and the Pantanaw township, with the exception of Bawdi and Kalaung circles, while the traverse survey has extended over the Pantanaw and Donubyu townships up to the Bassein boundary on the west and Henzada on the north.

214. The health of the party has not been as good as usual. There was a severe outbreak of cholera in several circles of districts Bassein and Thongwa, from which 17 men died besides 8 from other causes, while 24 men were invalided and sent back to India before the field season closed. The latter were for the most part broken down by fever and dysentery, the prevailing maladies in these districts, of which large tracts are covered by malarious jungle and swamps.

215. The areas traversed and cadastrally surveyed in each district are shown in the following statement :—

Districts.	Cadastral Survey, 16 inches to a mile.		Traverse Survey.		Topographical Survey, 2 inches to a mile. Area.	Remarks.
	Number of Kwins.	Area in square miles.	Number of Kwins.	Area in square miles.		
Bassein	33	61·61	20	18·59	35·68	The traverse survey includes 149 Kwins, area 430·18 square miles, prepared in advance for next season.
Thongwa	281	729·59	291	901·47	8·00	
Total	314	791·20	311	920·06	43·68	

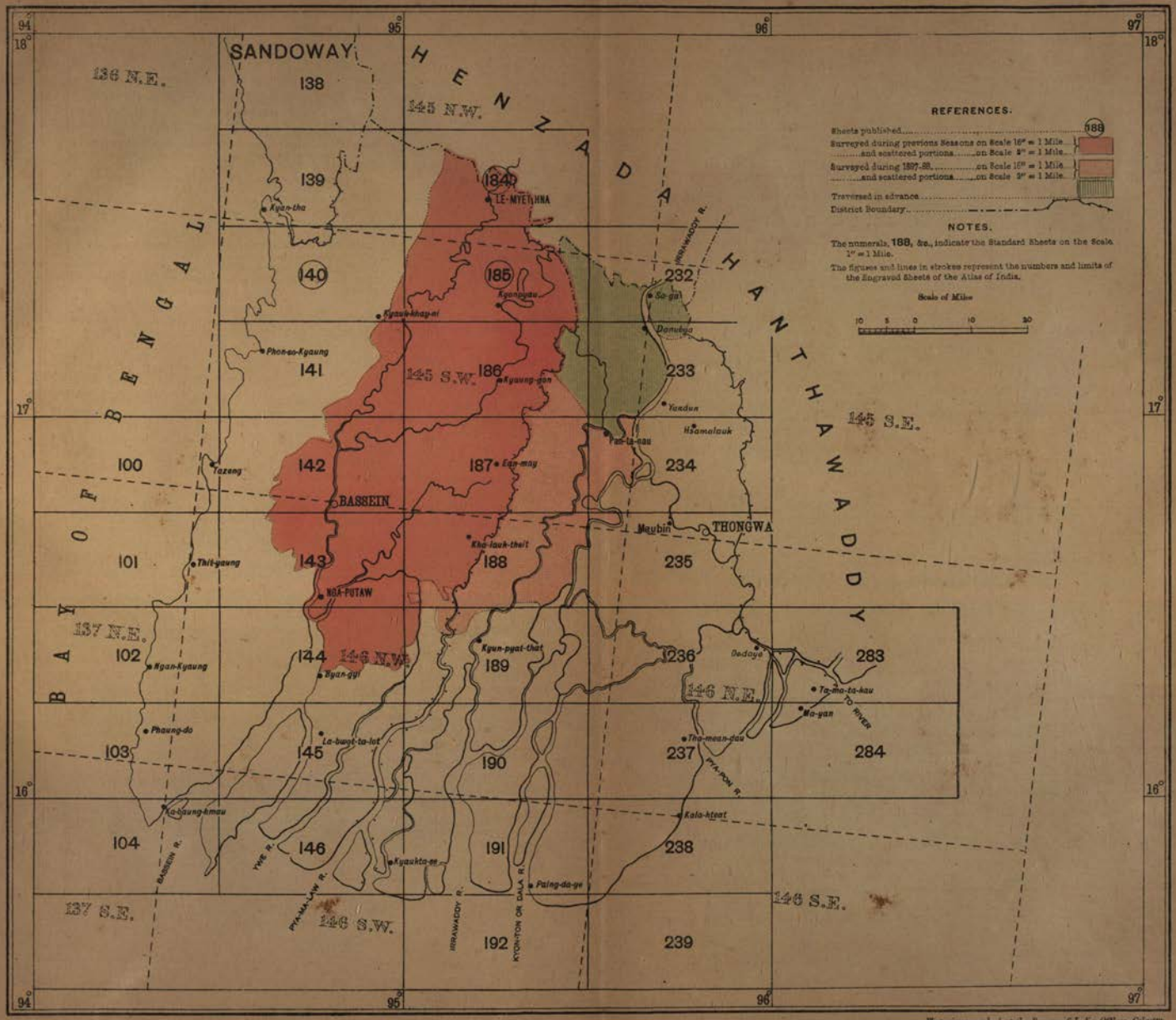
216. The separate areas of cultivation and waste land, which are in about the same proportion as found in previous seasons, are as below :—

	Bassein. Square miles.	Thongwa. Square miles.	Total. Square miles.
Cultivation	31·51	167·76	199·27
Jungle and waste, including water	30·10	561·83	591·93
Hills (surveyed on 2-inch scale)	35·68	8·00	43·68
Total	97·29	737·59	834·88

LOWER BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTS. BASSEIN & THONGWA.

No. 7 PARTY.



REFERENCES.

Sheets published 188

Surveyed during previous Seasons on Scale 16" = 1 Mile
.....and scattered portions.....on Scale 8" = 1 Mile.

Surveyed during 1897-98.....on Scale 16" = 1 Mile
.....and scattered portions.....on Scale 8" = 1 Mile.

Traversed in advance .....

District Boundary .....

NOTES.

The numerals, 188, &c., indicate the Standard Sheets on the Scale 1" = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved Sheets of the Atlas of India.

Scale of Miles

10 5 0 10 20

Published under the direction of Colonel H. R. Thuillier, R.E., *Surveyor General of India.*
Survey of India Office, Calcutta, December,
1898

Photozincographed at the Survey of India Offices, Calcutta

In the cultivated areas in both districts there are 256,081 fields of an average size of half an acre.

217. All theodolite traverse stations, numbering 10,757, have been marked with pottery cylinders sunk flush with the ground and covered over after survey with mounds of earth to protect them. The marks were at the same time placed under the care of the village headmen who by the Burma Boundaries Act are under obligation to look after them. The detail survey was tested by 733 linear miles of check surveys, of which 194 miles were measured by European assistants and 539 miles by native inspectors. The traverse survey was checked and regulated by 62 observations for azimuth.

218. Revision survey operations in the tract surveyed during the previous season, following, according to the system prevailing in Burma, a settlement staff which is employed to mark out the cultivators' holdings on tracings of the cadastral maps, have been completed in two circles of Bassein, and the maps of these have been finally prepared for printing. The revisions, which were found to be required, were almost entirely due to the limits of garden lands in jungle not having been defined at the time of survey.

219. The scheme mentioned in detail at paragraph 197 of last year's report which was initiated by the Local Government with the object of inducing Burmans to continue in more regular employment with the Survey Department than hitherto, by granting rewards payable after five years' continuous service, has now had the test of a second season as regards the effect it would have on the individuals to whom rewards had been assigned for the work of the first season, and it can only be said to have had a partial success, as out of 15 field surveyors, who had earned rewards, only 7 returned for a second field season. Also of 30 others who had been instructed last field season, but who had not earned either leave pay or deferred pay, only 9 rejoined, making in all 16 surveyors who returned out of a total of 47 who had been attached to the party the previous season either as surveyors or apprentices in training. It would appear therefore that the Burmans still join the survey party for the sake of the instruction in surveying which it affords to them, and the present inducements of deferred pay seem to be insufficient to lead them to return to serve as field surveyors season by season. During the season of 1887-88, 5 out of the 7 surveyors of the first season have qualified for additional deferred rewards; and out of 38 who were newly employed 17 have qualified, a lower qualification being accepted in the case of the new men. The total of the deferred pay earned by 22 men to be drawn and placed in the Government Savings Bank on their behalf is ₹424, giving an average of ₹19 per man. During the recess, 45 Burmans and Karens have been employed in various branches of office work.

220. The cadastral area in Bassein and Thongwa has been mapped in 995 sheets, of which 82 belong to Bassein and 913 to Thongwa. These sheets are retained in the party office as usual pending revision survey next season. Of the sheets of the past season, of which 481 belong to Akyab and 280 to Bassein, all have been sent to Calcutta to be printed, except a few sheets of the Myaungmya circle of Bassein. The 36 quarter sheets on the 2-inch scale of the Akyab district, which include the hilly tracts surveyed by a topographical detachment last season, are being steadily completed and sent up for publication. The 2-inch sheets of the recently surveyed portion of the Bassein district have been projected.*

* Mr. Kelly reports very favourably on the services of Messrs. Littlewood, Jarbo and Swiney, in charge of sections, as well as on the efficient aid rendered by the junior officers, Messrs. Beechey and Haddock.

The following members of the native establishments are favourably mentioned, *viz.*—of the *permanent establishment*, Moung Hpo Kah, Issan Chunder Ghosal, Nund Lall Chatterjee, Shashi Bhusun, Preonath, Kedarnath, Deendyal, Faiz Bukhs, Mohamed Hossen, and of the *temporary establishment*, Mahtab Khan Golam Kadir, Khodabux, Gopal Das, Moung Do Khine, Moung Chein, Moung Hpo Thin, Mewa Ram and Mowla Bux.

BENGAL AND ORISSA.

No. 8 Party.

221. This party has continued to work in detached sections under Surveyors and Assistant Surveyors, as in the previous season, the head-quarters of the party being retained in Calcutta on account of the continuance of the Calcutta Town Survey of which the Deputy Superintendent is the gazetted Superintendent.

Personnel.

Lieutenant-Colonel W. Barron, S.C., Deputy Superintendent, 2nd grade. In general charge up to 15th July 1888.
Lieutenant-Colonel S. H. Cowan, S.C., Deputy Superintendent, 3rd grade. In general charge from 16th July 1888.

Calcutta Section.

Mr. D. Atkinson, Surveyor, 1st grade.
Mr. A. B. Smart, Assistant Surveyor, 3rd grade.
5 Draftsmen, Computors, and others.

Temporary Establishment.

58 Field Surveyors and others.

Sankarpur and Maldwar Section.

Mr. T. Shaw, Assistant Surveyor, 1st grade.

Sankarpur and Maldwar Section—contd.

Mr. C. G. Lee, Assistant Surveyor, 3rd grade.
10 Sub-Surveyors and others.

Temporary Establishment.

185 Field Surveyors and others.

Angul, Bánki, and Kujang Sections.

Mr. R. B. Smart, Surveyor, 4th grade.
„ R. C. D. Ewing, Officiating Surveyor, 4th grade.
„ J. A Higgs, Assistant Surveyor, 2nd grade, up to 7th February 1888.
„ C. S. Gasper, Probationary Assistant Surveyor, 3rd grade, from 2nd March 1888.
15 Sub-Surveyors and others.

Temporary Establishment.

97 Field Surveyors and others.
371 *Sarbarákárs.*

222. Besides the survey of Calcutta, which constitutes the employment of the first section, the work of the second section in the Ward's Estate of Sankarpur in the Dinagepore district has been continued as in the previous season, but with the addition of the survey of the Ward's Estate of Maldwar in the same district. Likewise, the third section has continued the cadastral survey in the Government Estate of Angul in Orissa, but has further undertaken the topographical survey of the jungle tracts and of a Forest Reserve in the same estate. Finally, a fourth section has been formed for the cadastral survey of the Government Estate of Bánki in Orissa now forming part of the Cuttack district, and to this section has also been assigned the survey of Killa Kujang in the Cuttack district, being part of the estate of the Maharajah of Burdwan who is at present a Government ward. Colonel Barron held charge of the party up to 15th July 1888, when on his proceeding on three months' privilege leave necessitated through ill health, the charge was assigned to Lieutenant-Colonel S. H. Cowan of No. 4 Party who was temporarily transferred for the purpose. The camp of the third section at Angul was visited by Colonel Barron during December 1887, and the recess offices of this section and of the fourth section were visited by Colonel Cowan at Cuttack during September. The recess office of the second section at Dinagepore was visited by Colonel Cowan during September.

The following are the names of the officers who have held immediate charge of the several sections:—

Mr. D. Atkinson, Surveyor, 1st grade, conducted the Calcutta Survey under the direction of the Deputy Superintendent.

Mr. T. Shaw, Assistant Surveyor, 1st grade, supervised the section engaged on the surveys of the Sankarpur and Maldwar Estates.

Mr. R. C. D. Ewing, Surveyor, 4th grade, supervised the section engaged on the survey of the Angul Estate.

Mr. R. B. Smart, Surveyor, 4th grade, supervised the section employed in the Bánki Government Estate and in the Kujang Ward's Estate.

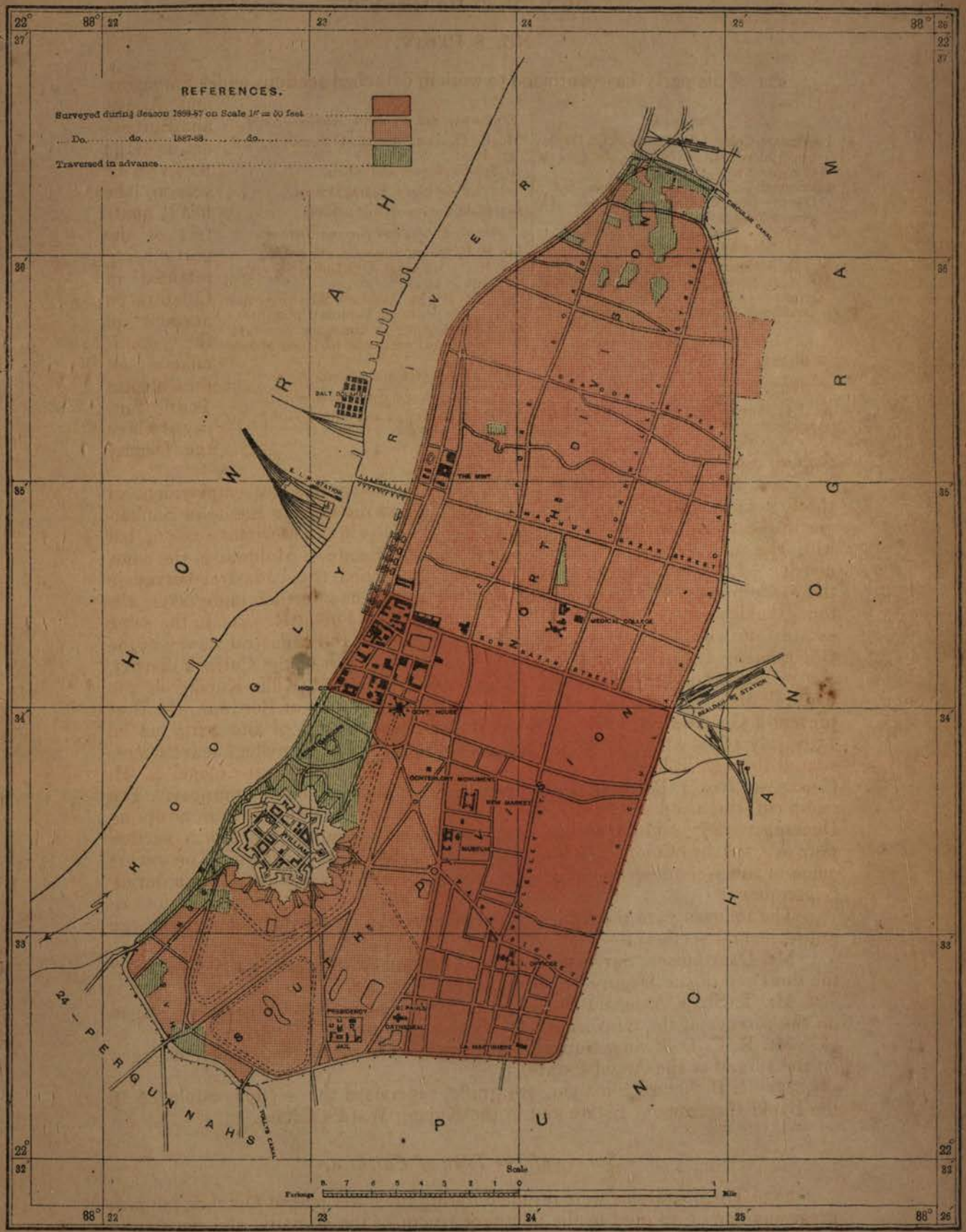
Survey of the Town of Calcutta.

223. The operations were resumed during the latter part of October, but progress was slow on account of the failure of 10 out of the 30 native surveyors (who were all from Upper India) to rejoin from leave, and though new men were gradually trained, a sufficient establishment was never obtained, and partly from this cause and partly from the delay in the survey of the very intricate parts of the northern division of the Town, the work had to be carried on without intermis-

BENGAL SURVEY.

INDEX TO THE SURVEY OF THE TOWN OF CALCUTTA.

No. 8 PARTY.



Reg. No. 505, S. I. O.—22-2-89.—500.

Photo., S. I. O., Calcutta.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN THE SANKARPUR ESTATE.

No. 8 PARTY.

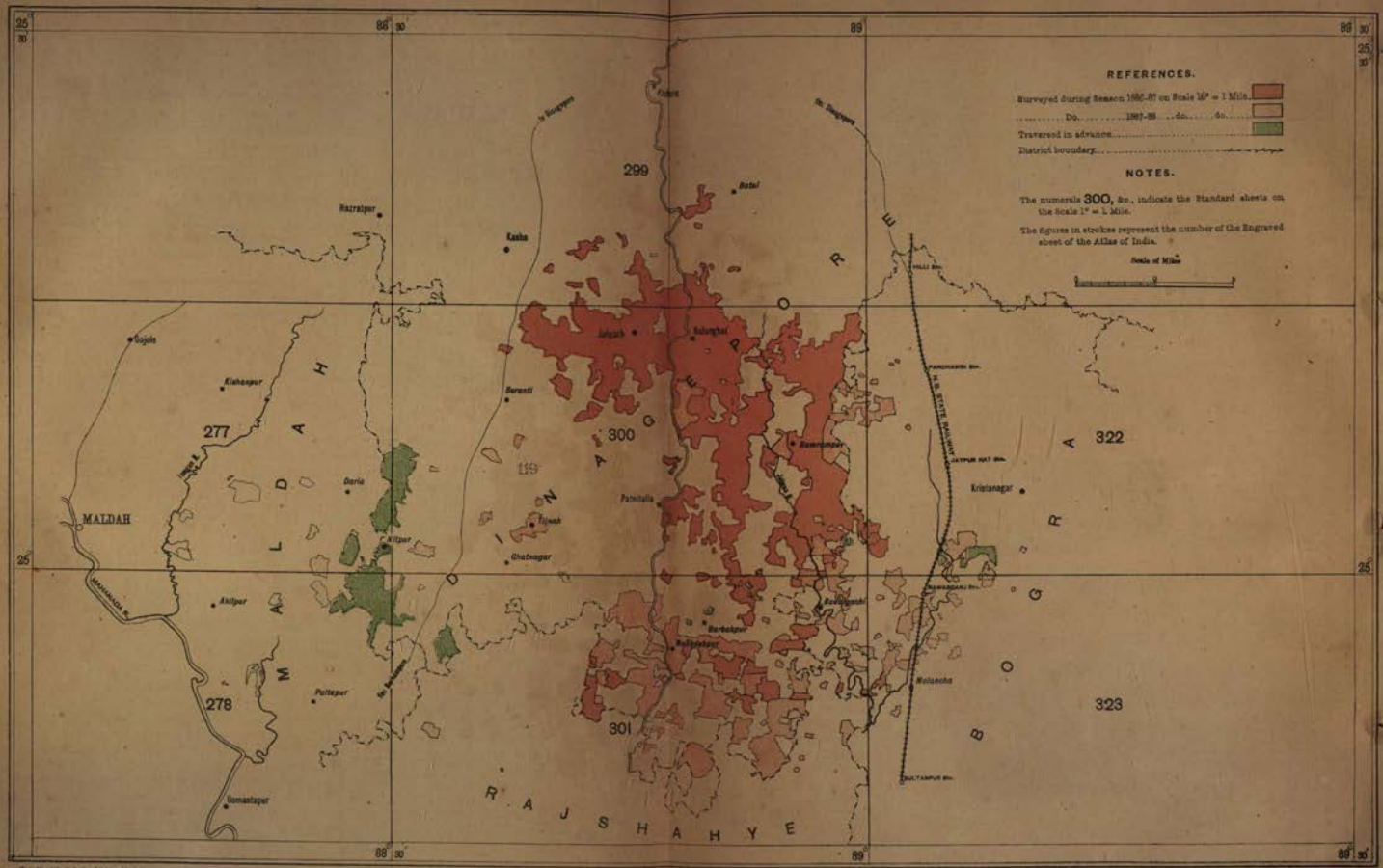


Photo. S. I. O., Calcutta.

sion throughout the season. The rainy weather was found not to interfere much with the out-of-door work, and there was a decided advantage in keeping on the establishment after it had been collected. By the 30th of September only a few small portions at which the surveyors were working remained to be done, and these have since been finished. The separate areas surveyed in different parts of the town are the following :—

	Acres.	Sq. miles.
Town of Calcutta, North of Bow Bazar . . .	2,116	= 3·31
Hastings	60	= 0·09
The Esplanade	924	= 1·44
TOTAL .	3,100	= 4·84

The scale of survey is that of 50 feet to an inch, and the same standard of accuracy was maintained as during the previous season, the checks which were instituted showing that the extreme accidental error in the position of details is not more than one foot and a half.

224. As during the first season, the method of survey has been for the traverse plots (each averaging 3·8 acres) to be first sub-divided by fixed lines and then for the detail measurements to be inserted direct on the plans. In carrying out the investigation regarding the boundaries of holdings for which the old plans of Mr. Heysham's survey could not be taken as exact guides on account of their small scale, the first procedure was to obtain, by a house-to-house inquiry, the names and addresses of the proprietors who are mostly non-resident in order that special notices might be issued for their attendance on fixed days and hours. The European officers of the survey who have invariably carried out this duty personally, having thus secured the attendance of the proprietors on both sides, then proceeded to insert the boundaries on the previously surveyed plans of the native surveyors. In this way the boundaries of 5,509 holdings have been investigated to 30th September 1888, bringing the total, including those of last season, up to 8,236 holdings investigated to date. The total number of disputes (or claims) as to boundaries which have been met with amounts to 265, of which 225 have been settled through judicial proceedings by a Deputy Collector, who has been appointed an Assistant Superintendent of Survey under special provisions in "the Calcutta Survey Act, 1887."

225. The house-to-house inquiry with regard to the names of proprietors and their subsequent attendance, either in person or through agents, enables an accurate register of present proprietors to be prepared, which will be available for the correction, if required, of the register in the Collector's Office which, as mentioned in last year's report, has become out of date through the changes of names not having been kept up.

226. In consultation with the Engineer to the Calcutta Municipality, the design of the final sheets of the survey as they will be published has now been settled, and 71 sheets have been projected of which 10 have been partially drawn. The true margins of the sheets measure 26″ × 18″, but by using full size Imperial paper (30″ × 22″) provision has been made for repeating from adjoining sheets the details of houses or of holdings which are cut through by the marginal lines, and thus each sheet will be rendered complete in itself as to the houses or holdings, parts of which only properly appertain to it. There will be about 235 of these sheets, each containing 1,170,000 square feet or 26·86 acres. During the season, 421 original plane-table sheets have been surveyed of various sizes according to the spaces between lanes and streets which form their margins. These are being carefully completed with distinctive drawing as to different items, and with colours, so that in the matter of details they may be rendered of the best possible value for future reference as original records.

Survey of the Ward's Estate of Sankarpur in Districts Dinagepore, Bogra, Rajshaye and Maldah.

227. The section employed on this survey, which had recessed during 1887 at Kurseong, returned to Dinagepore on 4th November, but met with considerable opposition from the *zamindárs* and *raiyats* on making an attempt to resume measuring operations so early as November, while the rice was still standing in

the fields. After some delay, the opposition was overcome through the intervention of the Collector of the district and the survey proceeded, but a passive resistance was still maintained, especially by the *zamindárs* of the interlaced estates, by which progress was much hindered.

228. The villages surveyed this season are much scattered, being spread over a length of 55 miles and breadth of 43 miles covering a tract of about 1,400 square miles, while the summation of the village areas brought under survey is only about 110 square miles: thus there has been great loss of time through the survey squads moving from village to village, and much greater expenditure on the traversing than ordinarily occurs when a continuous tract is being surveyed. Each detached village or small group of villages has been separately traversed and left disconnected with each other, and the relative positions which have been assigned to them on the index maps have been obtained from the maps of the former surveys of the several districts. The traversing has been now done for 161 villages, in area equal to 92 square miles, giving a total for the traverse survey, inclusive of last year's work, of 337 square miles in 834 villages. The detail survey has been effected this season in 338 villages of an area of 110 square miles, bringing the total of the detail survey to date up to 809 villages, in area equal to 310 square miles, and leaving 25 villages in area equal to 27 square miles which have been traversed, still to be surveyed in detail. But the whole of the villages of the Sankarpur estate are not thus accounted for, as there are several villages yet unrecognized on the maps of the former survey owing to the difference of names on the estate list which remain to be pointed out and demarcated by the estate officials. Among the villages which have been surveyed, 10 of them for a long time remained undemarcated, the estate officials being in ignorance of their situations.

The number of villages and areas surveyed in the several districts are shown in the following statement:—

District.	Number of villages.	Area. Square miles.
Dinagepore	210	62·55
Bogra	110	43·51
Rajshahye	13	1·55
Maldah	5	2·26
TOTAL	338	109·87

229. The area surveyed this season contains 169,840 fields, the survey of which has been tested by 245 linear miles of check surveys and the *khasra* entries concerning them have been examined for 34,440 numbers. Besides the above checks instituted by the survey staff, the settlement officer was also engaged in checking both the survey and the records.

230. Sickness told early on the *amins* engaged on the detail survey, and on two men dying the desertions were frequent. Out of 61 *amins* employed from time to time, 26 absconded and the district got such a reputation for unhealthiness among up-country *amins* that none could be induced to serve in that part of the country. To try to finish the work during the season new *amins* were sent for, but out of 30 who agreed to come only 3 presented themselves. Under these circumstances it was found to be impossible to finish the survey of the estate during the season as had been expected.

Survey of the Ward's Estate of Maldwar in Districts Dinagepore and Purneah.

231. The traversing of a compact block of villages of one part of this estate in the Dinagepore district had been effected towards the close of the previous season. Traverse plots were thus ready for the cadastral survey of these villages to be undertaken at once, and this work was commenced on 20th November 1887. The rest of the villages of which the estate is composed are very much scattered, some villages being situated on the eastern border of the Dinagepore district and others 85 miles away to the south of the town of Purneah.

BENGAL SURVEY.

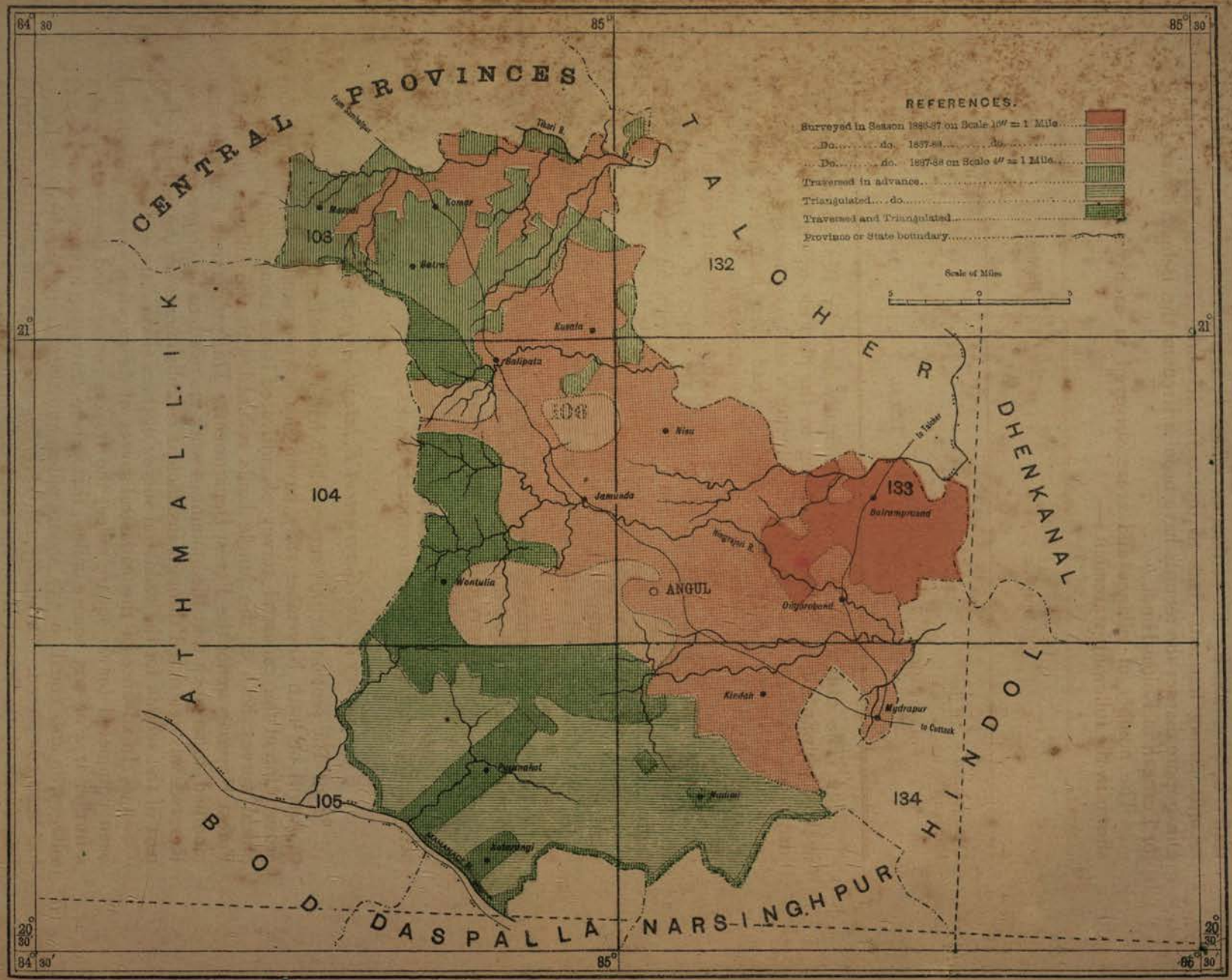
INDEX TO THE CADASTRAL SURVEY IN THE MALDWAR ESTATE.

No. 8 PART.

ORISSA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN THE ANGUL GOVT. ESTATE.

No. 3 PARTY.



Reg. No. 595, S. I. O.—22-3-89.—650.

Photo., S. I. O., Calcutta.

To complete the traverse survey of the estate, 164 villages containing an area of 106 square miles have been traversed this season; and the detail survey has been extended in all to 226 villages in area equal to 141·5 square miles, 26 villages having an area of 15·4 square miles being still left for detail survey next season. The detail survey, which included the mapping and writing of the records for 132,225 fields, has been tested by 340 linear miles of check surveys and by the entries in the records for 35,478 fields being checked by the survey staff; besides which, the settlement officer exercised additional checks on the records during frequent visits to the *amins* at work. For the villages in the Dinagepore district the records have been written in the Bengali character and for Purneah in Kaithi-Hindi.

The number of villages and areas surveyed in each of the districts are shown in the following statement:—

District.	Number of villages.	Area. Square miles.
Dinagepore	143	94·37
Purneah	83	47·15
TOTAL	226	141·52

232. The cadastral survey was principally done by Bengali *amins* trained in the Maldwar Survey School according to the plan for which the school was instituted, but there was difficulty in inducing a sufficient number of the pupils to remain for the work of the survey after they had been instructed, and as the progress of the newly trained men was necessarily slow, the completion of the survey during this season has failed through an inadequate establishment. Out of 213 pupils who attended the school, 138 are reported to have qualified as surveyors, but only 58 of these remained to serve with the survey and 75 left without qualifying.

233. Besides the drawback of having to work with newly trained *amins*, there were great delays through the failure of the villagers to furnish the requisite labour for chaining and carrying instruments. This plan of free labour which had been adopted on the expectation of its saving expenditure to the estate, which is meeting the entire charge for the survey, proved to be one of doubtful economy, considering how much the progress of the survey was retarded by it.

234. As a temporary measure, the tri-junction points of villages have been marked with pottery cylinders, the estate authorities not having procured a supply of markstones in time, but these have since been sent for and are now being put down in place of the temporary marks.

Survey of the Government Estate of Angul, Orissa.

235. The section for this survey which had recessed at Cuttack, moved out to Angul on 15th November 1887, having for its programme the simultaneous prosecution of the cadastral survey of cultivated lands along with the topographical survey both of the jungle lands retained with the villages and of the Forest Reserves under the Forest Department. This programme was somewhat modified, in so much that the amount of work intended to be done on the Forest Reserve was restricted through insufficient establishments on the withdrawal of part of the section for the cadastral survey of the Bánki estate.

236. In advance of the cadastral survey of the previous season (which had been completed for 61 square miles) the traverse survey had been extended for a further area of 293 square miles; this season, traversing has been done for 254 villages, in area equal to 337 square miles, and the traverse survey of the estate has been completed. Ordinarily, the traversing has been restricted to the exterior boundaries of the Forest Reserves which constitute a large portion of the estate, but it has been extended in parts within the reserves to determine the boundaries of 33 in-lying villages. The traverse of the estate boundary, though completed and done this season for 80 linear miles, may be found not to indicate the true boundary, as there is great uncertainty about this part of the boundary which is

now being exactly demarcated for the first time, and second traverse lines have been measured to the extent of 53 linear miles to exhibit the boundary claims of the adjoining tributary estates. The erection of the masonry pillars, intended to be placed at intervals of a quarter of a mile on the estate boundary, is deferred until the disputed portions have been adjusted.

237. Under the plan of operations referred to in paragraph 223 of last year's report, the cadastral survey and writing of the records were to be done by the *sarbarákárs*, or village head-men, who had been trained during the previous field and recess seasons, and it was intended as part of the prescribed plan that these officials should be required to carry out the operations without any additional remuneration beyond what they received as percentages on the rental collections. The *sarbarákárs*, however, insisted that they must be paid for the survey work they might be required to do, also representing quite reasonably that expenditure would have to be incurred by them on account of chainmen and instrument-carriers; eventually it was decided in communication with the Director of Land Records, after considerable delay during which time no work was done, that payment should be made at the contract rate of four rupees per hundred acres. Further delay was occasioned pending receipt of orders from the Board of Revenue on a reference by the Director of Land Records proposing the transfer of the cadastral survey to the settlement officer, and the work was not fairly begun until 5th January. Field operations were continued up to 20th June.

238. With few exceptions all the *sarbarákárs* who had been trained have been employed, the number who actually worked being 286, and ordinarily each man has surveyed the village over which he enjoys *sarbarákári* rights. A few men were inclined to be refractory and at first refused to work, but on being made to understand that *amins* would be engaged to do the survey of their villages at their expense, they mostly complied with the orders and either surveyed themselves or provided substitutes. The *sarbarákárs* only surveyed the cultivated lands, and special surveyors were employed to complete the topography on the village maps for the waste land tracts.

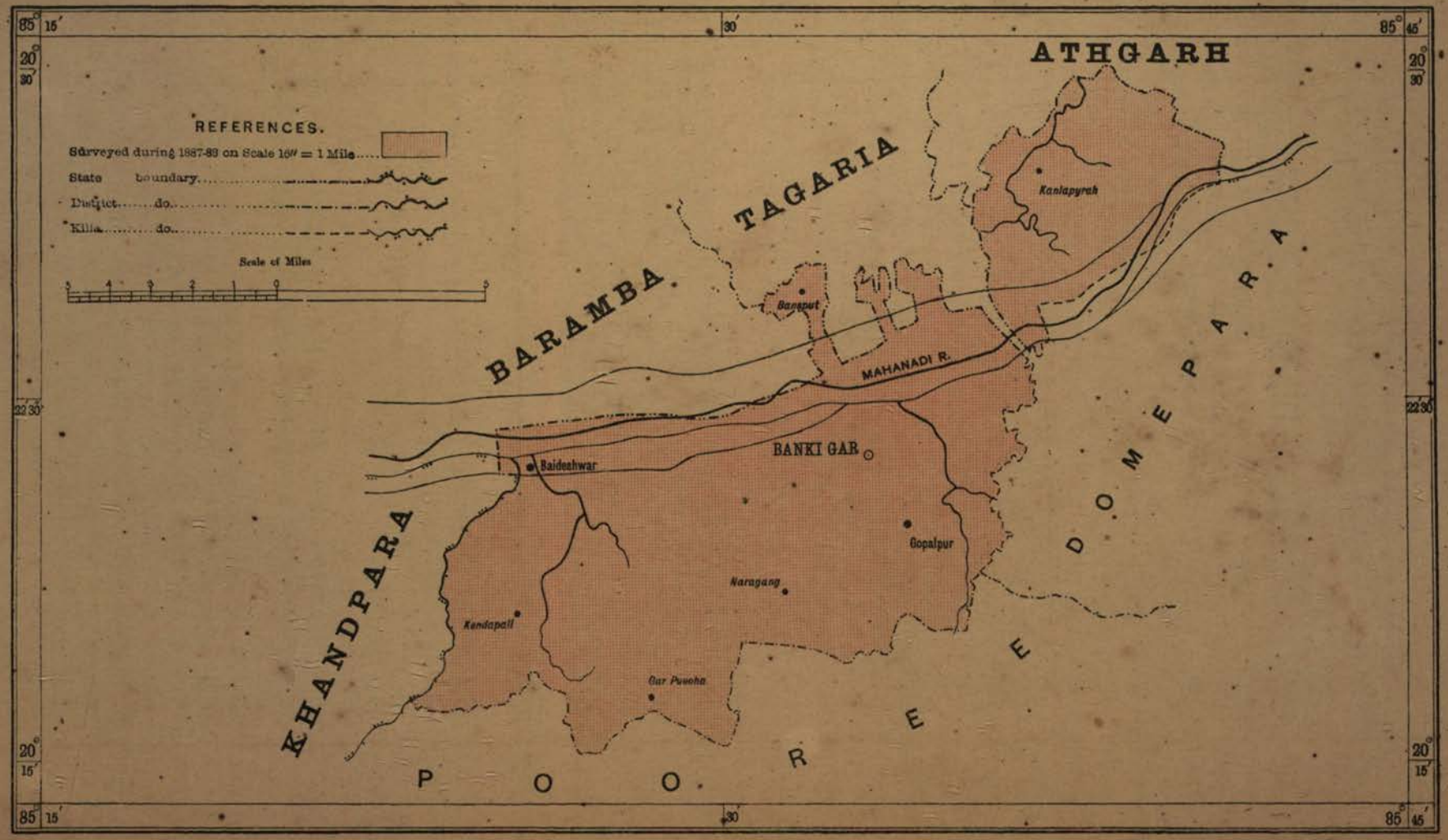
239. The gross out-turn is 329·71 square miles of 16-inch survey comprised in 385 villages, which contain 191,462 fields. One village has been entirely surveyed on the 32-inch scale on account of the minuteness of the fields, and portions of other villages, where intricate village sites were met with have also been mapped on the increased scale. The unit of measurement designated a "field" is a plot of ground of one class of soil and in the occupation of one tenant, notwithstanding that it may be sub-divided by one or more ridges into *kiáris* for the convenience of agriculture. By omitting the *kiáris*, which has been done to reduce expenditure on the survey and to save the necessity for an extensive increase of scale, the value of the maps as complete indexes to all the features of the country has been to some extent impaired.

240. The survey work done by the *sarbarákárs*, as tested to the ordinary extent by the European officers and by native inspectors, was found with few exceptions to be accurate, but the *khasra* entries, also tested to the usual amount, were not reliable and in many cases were designedly falsified, the *sarbarákárs* being found to have taken advantage of their position to register in their own names fields which they knew belonged to others who were too illiterate to detect the false entries on the spot. In several villages the *khasra* had to be wholly revised.

241. For the topographical survey of the waste lands and of the Forest Reserves, triangulation had to be undertaken throughout the interior of the hilly tract, in combination with the traverse survey of the exterior boundaries, and the triangles which are based on four stations of the Great Trigonometrical Survey, have embraced an extreme area of 425 square miles, within which 32 stations of observation have been established and 116 points fixed by intersection, the heights of all the stations and points having been also determined and the ground in every way prepared for topographical survey. The topography has likewise been done for 51 square miles of the waste lands and for 36 square miles of the Forest Reserves; this part of the work has been restricted by the formation of a new section for the survey of the Bánki estate. All the topography which has yet been done both for the waste lands (which consist of blocks of uncultivated lands or hills lying among the villages surveyed cadastrally) and for the Forest Reserves is on the scale of 4 inches to the mile, being the ordinary scale for Forest

ORISSA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN THE BANKI GOVT. ESTATE. No. 8 PARTY.



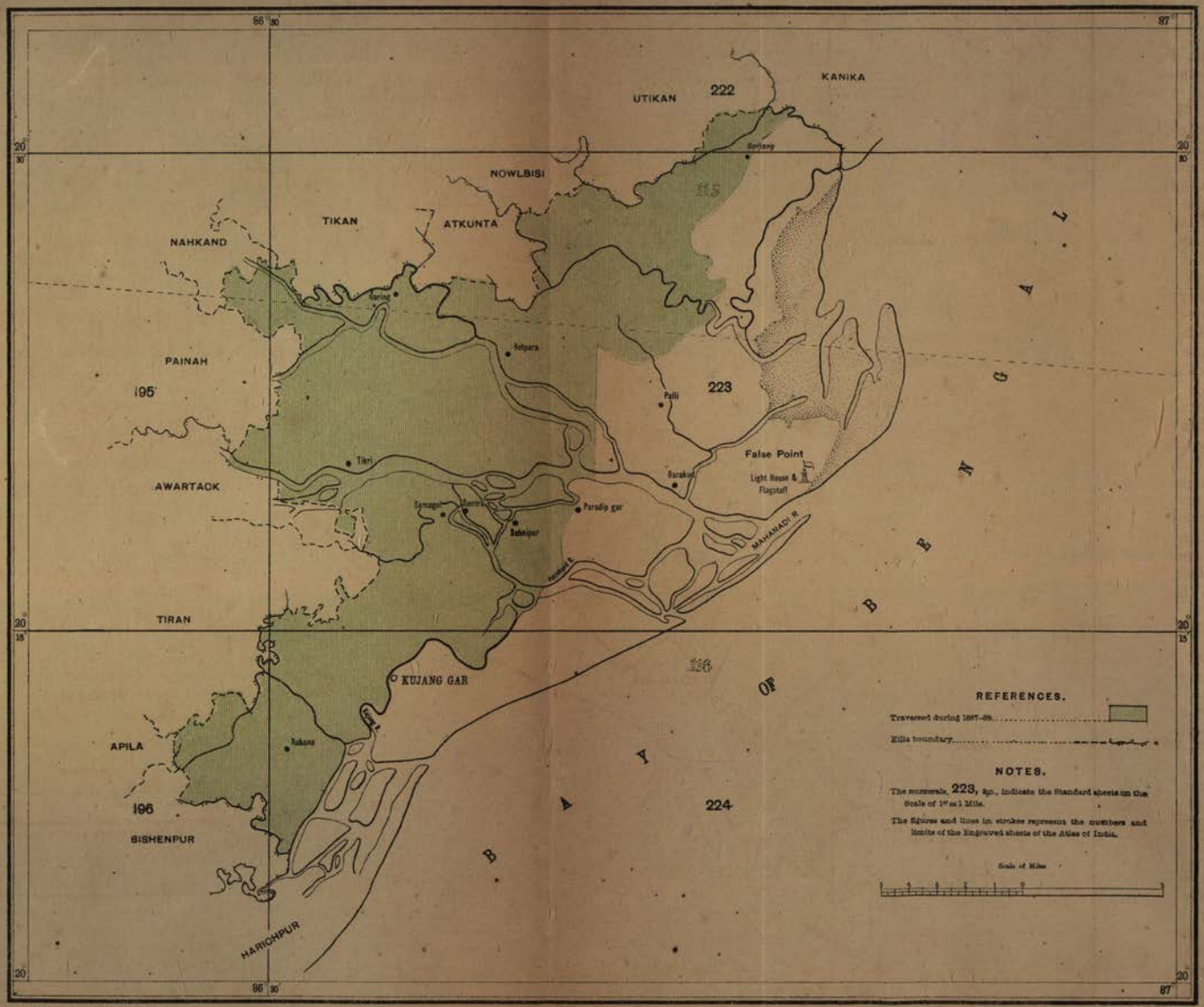
Reg. No. 628, S. I. O.—1-3-89.—550.

Photo., S. I. O., Calcutta.

ORISSA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN THE KUJANG ESTATE (BURDWAN RAJ)

No. 8 PARTY.



Reg. No. 845, S. I. O.—1-8-89.—250.

Photo., S. I. O., Calcutta.

surveys; but a special scale of 2 inches to the mile has since been prescribed for the Angul Forests by Government of Bengal letter No. 2138-382 For., dated 6th July 1888, and this scale will in future be adopted for the waste lands also and it will be the scale on which the general maps of the estate including the tracts surveyed cadastrally will be compiled.

Survey of Killa Bánki, District Cuttack.

242. Preparations had been made for the cadastral survey of Killa Bánki, a Government estate lying along the Mahanadi river about 25 miles from Cuttack, by the training of the *sarbarákárs* during the recess season of 1887. The village boundaries had also then been demarcated under the direction of the Collector of Cuttack, but the operations could not be begun until traverse surveyors could be spared from the Angul survey. When the surveyors were available, a new section was formed for this survey and the traversing was undertaken on 1st February 1888. A beginning of the cadastral survey was made about the middle of the month, and though delays frequently occurred through want of labour, for the supply of which the *sarbarákárs* were responsible under an agreement to carry out the field measurements and writing of the records either personally or through nominees at the fixed rate of four rupees per 100 acres, the work was completed by 19th June. Only 3 of the *sarbarákárs* worked personally out of 15 who had been trained, the survey having been done by sons or relatives of whom 50 worked out of 74 who had been trained; these were assisted by 32 local men who had voluntarily attended the training school and who were employed on the nomination of the *sarbarákárs* and under the approval of the settlement officer.

243. The area of the estate is 117·6 square miles comprised in 128 villages and containing 114,000 fields. Generally the scale of survey has been that of 16 inches to the mile, but on account of the small size of the fields, 20 sheets out of a total number of 198 have been plotted on the 32-inch scale and 11 on the 64-inch scale. Special forms of *khasra* and of other village papers to suit local requirements were drawn up by the surveyor under the direction of the Collector and in consultation with the settlement officer, and a complete set of instructions was at the same time prepared for the guidance of the *sarbarákárs* or their nominees in filling up the papers. This work of record writing, which was duly tested by the survey staff, was found to have been rendered to the settlement officer in such a manner as enabled him to accept all the entries subject only to the usual checks at the final attestation.

Survey of the Ward's Estate of Killa Kujang, District Cuttack.

244. This estate, the property of the Maharajah of Burdwan, lying along the Bay of Bengal has an area of 358 square miles, about half of which is cultivated while the part towards the sea is covered with jungle: it has been assigned to be surveyed cadastrally, but during the present season only traversing, and that confined to the cultivated tract, could be undertaken. The traverse surveyors began to be sent to the estate about 15th March, as they could be spared from the Bánki survey, and after meeting with many delays through the incomplete demarcation of the boundaries of the villages which were being for the first time definitely constituted, they succeeded by the end of the season in surveying 388 villages covering an area of 200 square miles.

245. For the cadastral survey, it had been intended that preparations should have been made during the recess season by the training of the *jimbadárs* (who are the persons who collect the rents), but owing to the men objecting to attend the training schools, and to an uncertainty about their rights which raised the question whether they could be compelled to attend, the recess season passed without the men having been trained. This matter has since been settled, but not until the field season had somewhat advanced, by the *jimbadárs* having been made content to undertake the survey at a rate which includes a higher payment for village labour than was allowed in Angul and Bánki, and the men are now working to the number of about 150.

246. The Deputy Surveyor-General in charge of the Revenue Branch, who has been in constant communication with Colonel Barron, desires to bring to notice Colonel Barron's exertions in connection with the Calcutta survey while

his health permitted and the administrative ability with which he has directed the various operations of the different sections.*

TRAVERSE SURVEYS.

PUNJAB PROVINCE.

No. 1 Party.

247. This party, on its recess office at Simla being closed on 11th October 1887, was organized for field duties as usual in two sections, in accordance with the main divisions of the work which the party is performing. The first section, intended for the traversing of revenue-paying districts, proceeded first to the Amritsar and afterwards to the Lahore district. The second section, intended for the testing and correcting of the topographical reductions obtained from the village maps of the settlement surveys, proceeded in the first instance to the Umballa district, whence on the completion of the work there it moved to the Ferozepore district to commence the testing in that district, as well as in the adjoining State of Faridkot, for which State village settlement maps were available for reduction the same as for revenue-paying districts. To this section was also allotted the special traversing required in the Sikh States to allow of the existing maps being redrawn on the maps of the new standard series. Field work was brought to a close by both sections on 8th May 1888.

Personnel.

Colonel F Coddington, S.C., Deputy Superintendent, 1st grade, in charge.
Mr. J. S. Pemberton, Surveyor, 1st grade.
Mr. C. W. Wilson, Assistant Surveyor, 1st grade, up to 9th December 1887.
Mr. G. Campbell, Assistant Surveyor, 1st grade.
Mr. W. H. D. Ewing, Assistant Surveyor, 2nd grade, from 17th December 1887.
Mr. F. P. Walsh, Assistant Surveyor, 3rd grade.
Mr. F. S. Bell, Assistant Surveyor, 3rd grade.
34 Sub-Surveyors and others.

248. The several operations on which the party is engaged have been the same as those of last season, and the description of them as given in last year's report is repeated for convenience of reference, *viz.*:—

(1) The skeleton traversing of villages for the purpose of determining the co-ordinate distances of the tri-junction points; and the projec-

* Colonel Barron reports as follows on the services of the officers who have held responsible positions in charge of sections.

"Mr. D. Atkinson in charge of the section engaged on the Calcutta survey has, as usual, worked well and has given great attention to the testing of the work and inquiring into the boundaries of holdings, of which out of 5,509 holdings that have been mapped he has personally investigated 4,656."

Mr. A. B. Smart, employed under Mr. Atkinson in testing the surveyors' measurements and in investigating the boundaries of 853 holdings, is favourably reported on. The names of computer Ganga Bishen and draftsman Rahim Bakhsh are favourably mentioned.

"The Deputy Superintendent desires to bring to notice the good work done by Mr. R. B. Smart, in charge of the Bánki and Kujang section. A combination was formed against him at Angul, and it was thought better that the cadastral work should be put into other hands, but his success in Bánki in carrying on the traversing and the interior survey without a hitch and doing the latter by the *sirbarákárs* or their nominees and the cordial relations between him and the Settlement Officer and the Collector show that he was opposed by an unreasonable combination about which it is needless now to write."

The following names of members of the native establishment serving under Mr. Smart are prominently brought to notice, *viz.*: sub-surveyors, Shaikh Abdullah and Gyasre Ram; computers, Shew Narain, Monohar Lall and Isar Chunder. Mr. A. Pyster, temporarily employed as a supervisor of the cadastral survey, is reported to be active and to have done good work.

"The Deputy Superintendent wishes to bring prominently to notice the good services of Mr. R. C. D. Ewing, in charge of the Angul section. Though he had not before done cadastral work and the Deputy Superintendent was diffident about putting him in charge, he has done the work well and with great zeal and intelligence. Working as he had to do with a set of untrained men, with a good deal of opposition to his work and with a field season which had to be prolonged into June because two months were lost in the beginning, it reflects great credit on him that he succeeded in turning out 330 square miles of cadastral survey besides the triangulation of 425 square miles and the survey on the 4-inch scale of 87 square miles of forest reserves and jungle tracts."

Of the establishment which served under Mr. Ewing, the following officers are mentioned: Mr. J. A. Higgs is reported to have done well until he fell ill on 21st January. Mr. Gasper, who joined on 14th March, is said to have worked steadily and with intelligence. Sub-Surveyor Ikbaludin is very highly commended for a large amount of good work done both in field and office. Sub-Surveyor Sakhawat Hossein is also commended.

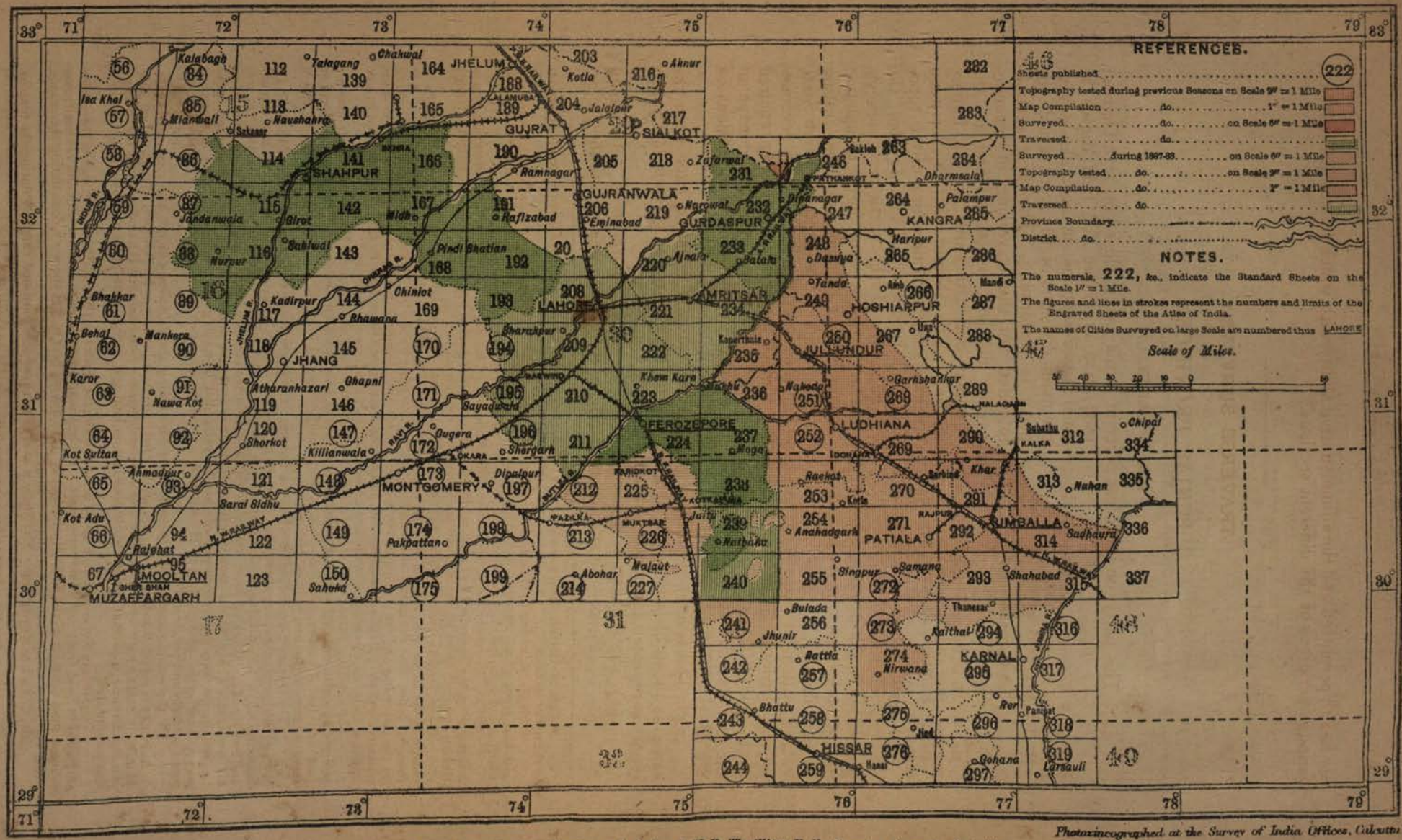
"The Deputy Superintendent would bring to notice the services of Mr. T. Shaw, in charge of the section employed in Sankarpur and Maldwar estates. He had many difficulties to contend with and his health has suffered from the fever of the Dinagepore district. He did his best to get the work done during the season under report but circumstances were against him."

Mr. C. G. Lee serving under Mr. Shaw is said to have worked hard and carefully during the time he was free from fever which eventually compelled him to take leave for 2½ months. Mr. Hickie, cadastral supervisor, is reported to have kept to his work manfully under trying circumstances.

PUNJAB SURVEY.

INDEX TO THE SURVEY OPERATIONS IN THE PUNJAB.

No. 1 PARTY.



Published under the direction of Colonel H. R. Thuillier, R.E., *Surveyor General of India.*
January 1868

Photozincographed at the Survey of India Offices, Calcutta

tion of maps of the tri-junctions on the scale of 2 inches to the mile.

(2) The insertion of topographical details on these maps by reduction from the settlement survey village maps.

(3) The testing and correcting (where necessary) of the reduced maps by examination in the field.

(4) The drawing of fair maps on the 2-inch scale.

(5) The redrawing of the old 1-inch maps of the Sikh States to complete the portions of these territories falling within the present continuous series of maps of standard size.

The areas accomplished during the season under these heads in the several districts are as shown below:—

Districts.	(1) Area traversed.	(2) Area compilation by reduction (2-inch scale).	(3) Area tested (2-inch scale).	(4) Area finally mapped (2-inch scale).	(5) Area compilation and final mapping (1-inch scale).
	Square miles.	Square miles.	Square miles.	Square miles.	Square miles.
Amritsar	1,573	...	...	...	...
Faridkot State	607	607	607	527	...
Ferozepore	...	25	1,141	913	...
Gurdaspur	...	18	18	18	...
Lahore	3,513	...	...	...	...
Ludhiana	102	...	102	61	...
Sikh States	...	...	99	99	3,850
Umballa	...	...	855	855	...
Totals	5,795	650	2,822	2,473	3,850

The operations under head (1) have been completed in Amritsar and Lahore districts, and in the Faridkot State; also, as concerns the skeleton traversing for map compilation, in the Sikh States. Under head (2), the operations are complete for the Faridkot State, also for the portions of the Ferozepore district for which settlement survey maps are available. Under head (3), the operations are complete for the Ludhiana and Umballa districts, and for the Faridkot State. Under head (4), the final mapping of sheets 213, 225, 226, 227, 249, 272, 293, 294, 315 and 316 is now complete. Under head (5), the compilation and drawing of the old maps of the Sikh States has been completed for sheets 227, 241, 254, 255, 271, 272, 273, 274, 291, 292 and 293, and thus there has been rendered in a form suitable for publication a large area of topography which, although not modern, is said to be fairly trustworthy, and as far as possible it has been supplemented by additions from the surveys of canals by the Irrigation department.

Reductions to the scale of the Atlas of India have been drawn for all the standard-sized sheets which have been compiled, covering a total area of 11,880 square miles, and furnishing materials for the revision of 6 of the engraved plates of the Atlas.

249. In addition to the areas shown in the table, 22 square miles have been surveyed on the 6-inch scale in Kashmir territory on the banks of the Ravi river as an extension of a survey carried out during the previous season in the Gurdaspur district with the object of facilitating the settlement of disputes which had arisen between British and Kashmir cultivators concerning the water rights from irrigation channels. All the survey work required to be done in connection with these disputes has now been completed.

250. In accordance with the design of the present operations that the traversing in revenue-paying districts, besides being executed for the purposes of map compilation, should also furnish data for testing the accuracy of the settlement survey village maps which are being constructed on a basis entirely distinct from the traversing, statements of co-ordinate distances of all village tri-junctions (which are the common points of the two surveys), and of the computed direct distances between tri-junctions, are being prepared for each of the districts. They

have been furnished for districts Ferozepore (as far as surveyed), Gurdaspur, Shahpur (as far as surveyed), Jullundur, Ludhiana, Hoshiarpur and Umballa, and they are nearly ready for Amritsar and Lahore. Excepting the village tri-junction pillars, which have invariably been adopted as theodolite stations, there are no other permanent marks for the stations of the traverse survey, but an attempt has been made to give the traversing a more permanent value than formerly by the expedient of fixing as many as possible of the intermediate stations on the sites of temporary boundary-marks in the expectation that the positions will be sufficiently well preserved for future identification.

251. The recess office of the party was inspected during October by the Surveyor-General, who was well satisfied with the progress that had been made in the mapping, which has been unusually heavy this year, and in the state of the records generally.*

NAGPUR AND WARDHA DISTRICTS, CENTRAL PROVINCES.

No. 3 Party.

252. This party, which had been employed for two seasons on the traverse survey of the Raipur district, was transferred for similar work to districts Nagpur and Wardha, leaving the remaining portion of the Raipur district to be completed by No. 2 Party in conjunction with its other work in the adjoining district of Bilaspur. The members of the office establishment who had been in recess quarters at Mussooree, and those of the field establishment who had been on leave, re-assembled at Nagpur on 1st November 1887. Field work in both districts was at once begun, and was continued up to 15th May 1888, when the office establishment again proceeded to Mussooree.

Personnel.

Lt.-Col. W. H. Wilkins, Deputy Superintendent, 2nd grade, in charge.
Mr. H. E. T. Keelan, Surveyor, 1st grade, from 1st November 1887, to 30th April 1888.
Mr. W. S. Buttress, Surveyor, 2nd grade.
Mr. A. Christie, Surveyor, 3rd grade, up to 31st October 1887.
Mr. C. Tapsell, Surveyor, 4th grade, up to 29th February 1888.
Mr. G. Vander Beek, Assistant Surveyor, 1st grade.
Mr. O. D. Smart, Assistant Surveyor, 2nd grade, from 20th February 1888.
Mr. W. J. Baker, Assistant Surveyor, 3rd grade, from 25th January 1888.
38 Sub-Surveyors and others.

253. The object of the traverse surveys of Nagpur and Wardha being to furnish skeleton plots for the purposes of a village settlement survey by *patwáris*, the same as in Raipur, the operations have been of the same character as were carried on in that district. In accordance with the requirements of the settlement surveys in the new districts, the traverse survey has been begun in the southern tracts of both districts and is advancing northwards. The work which has been accomplished in each of the districts is shown in the following statement:—

Districts.	Number of villages.	Number of traverse stations.	Area in square miles.
Nagpur	1,092	26,032	1,637
Wardha	722	16,883	1,273
Total .	1,814	42,915	2,910

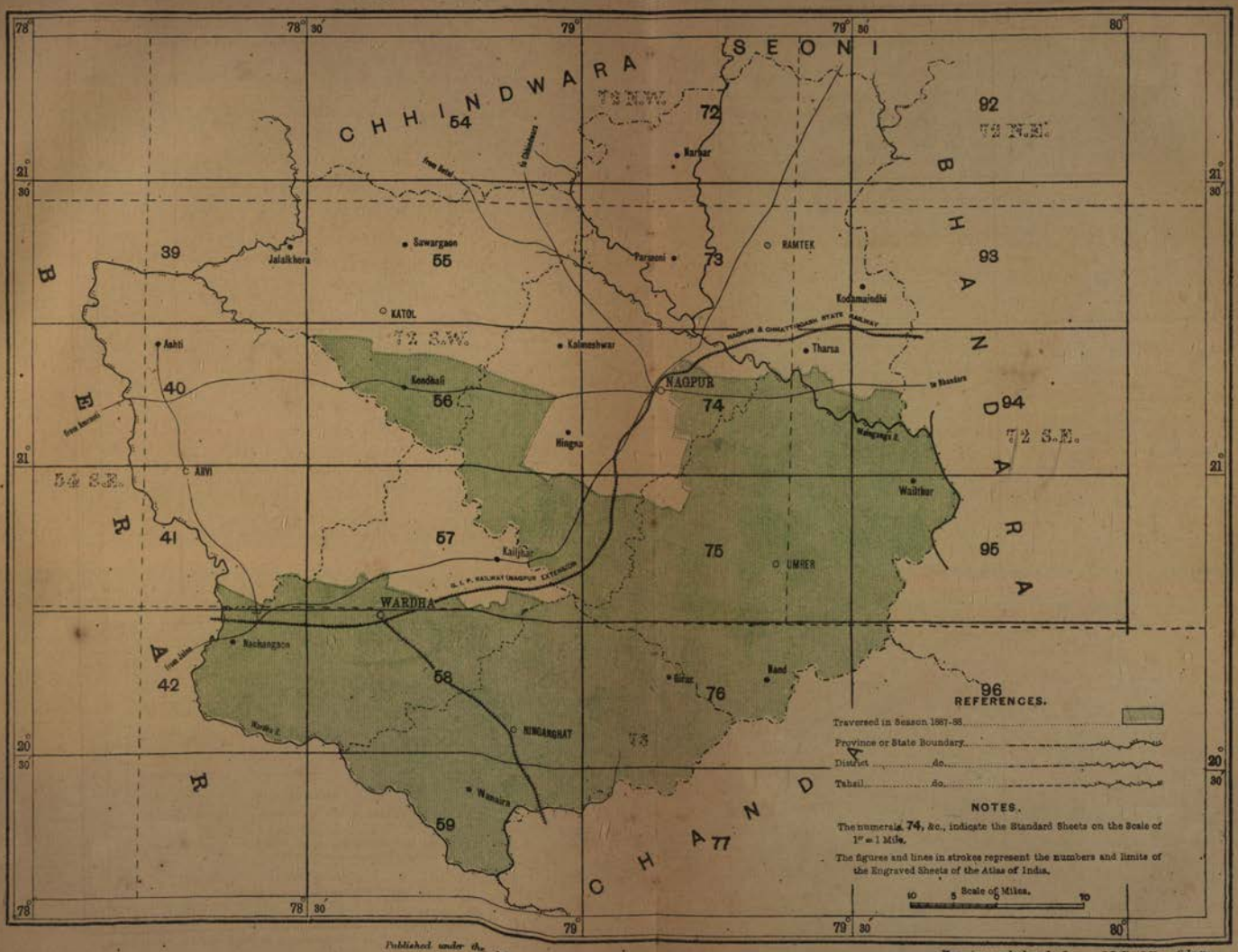
The total area is less than was accomplished last season in Raipur, the decrease being due partly to the country being more difficult for survey, much of it being hilly, and partly to the traverse lines having been kept closer to the village boundaries which has increased the number of the traverse stations.

* Colonel Coddington makes special mention of the good service rendered by Messrs. Pemberton and Campbell, in charge of sections, and reports favourably of Messrs. Ewing, Walsh and Bell. The native establishment are said to have all done well, but Elahi Bakhsh, Surajudin, Ramjas, Moula Bakhsh, Abdul Aziz (2nd), and Awaz Ali are specially mentioned.

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTRICTS NAGPUR AND WARDHA.

No. 3 PARTY.



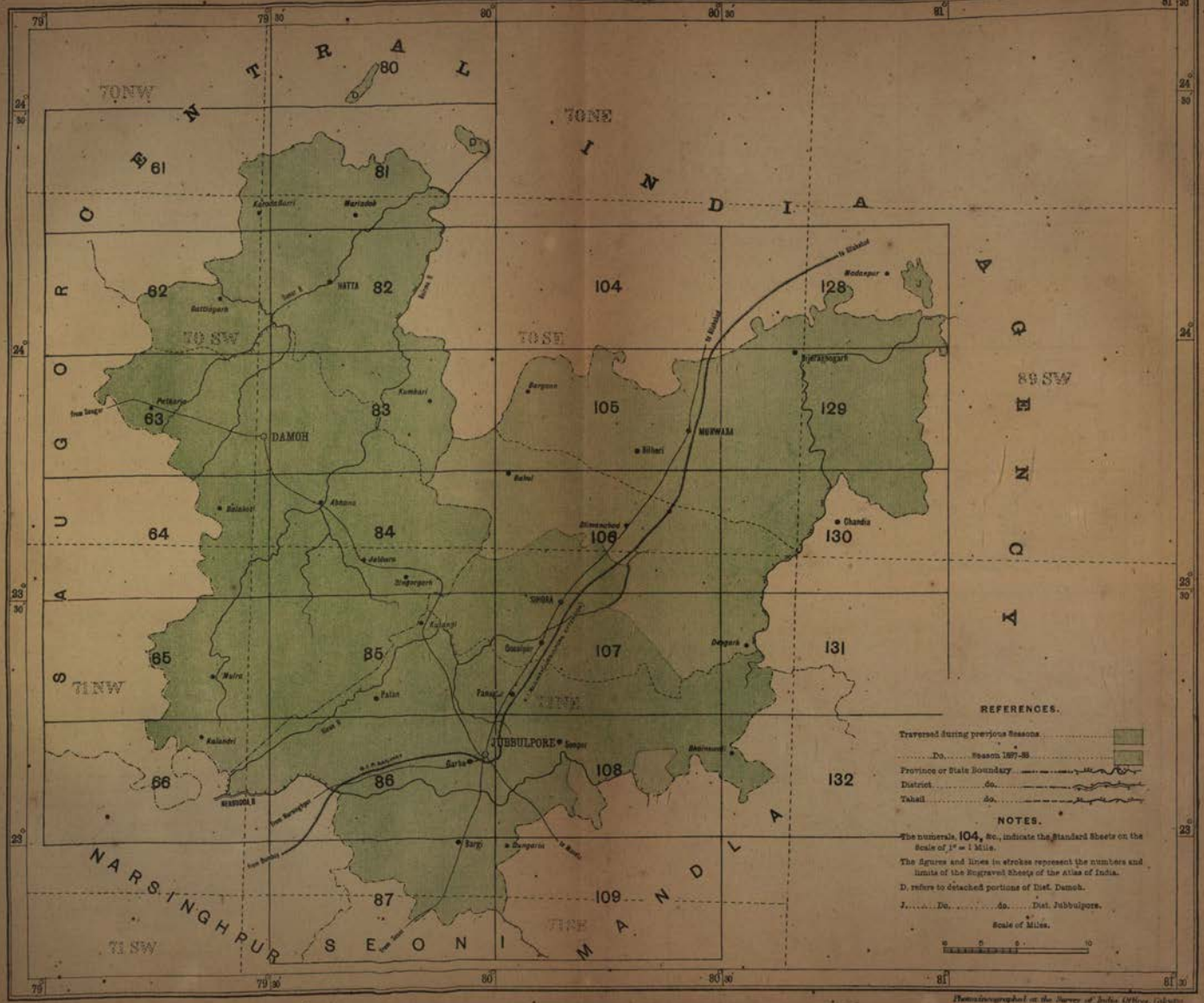
Published under the direction of Colonel H. R. Thuillier, R. E., *Surveyor General of India.*
Survey of India Offices, Calcutta, December
1888

Photozincographed at the Survey of India Offices, Calcutta.

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTS. JUBBULPORE AND DAMOH.

No. 9 PARTY.


CENTRAL INDIA
GONDWANA
SAUGOR
NARSINGHPUR
SEONI
MANDLA
70NW
70NE
70SW
70SE
71NW
71NE
71SW
71SE
79
80
81
24
23
61
62
63
64
65
66
81
82
83
84
85
86
87
104
105
106
107
108
109
128
129
130
131
132
DAMOH
JUBBULPORE
MUKWARA
NARBUDDA R.
Hatta
Patharia
Kumbari
Bilheri
Chanda
Singhpur
Gosalpur
Patan
Barha
Deogarh
Mudanpur
Bijeragarh
Bargaon
Bahai
Dhimarkhed
Sihora
Kalandri
Malra
Palan
Kanjhi
Bhainsaur
Sangaria
Tendukheda
Kareli
Gadarwara
Narsinghpur
Chhindwara
Betul
Multai
Amla
Itarsi
Harda
Khandwa
Hoshangabad
Sohagpur
Pipariya
Pachmarhi
Narmada R.
Tawa R.
Sonar R.
Ganjal R.
Sher R.
Dudhi R.
Bijul R.
Kanhan R.
Pench R.
Kolar R.
Bagra R.
Bhadar R.
Sukri R.
Sakkar R.
Sonbhadra R.
Singrauli R.
Son R.
Jhingra R.
Hiran R.
Gaur R.
Umrar R.
Ganjal R.
Bamner R.
Kundam

254. The masonry platforms at tri-junctions of village boundaries were nearly all found in good order, and stone pillars had been put up at most of the principal bends of the boundaries. These marks were therefore in readiness for adoption as survey stations; but they had to be supplemented by other stones which the surveyors were able to procure in most villages of suitable size and shape. The forest boundaries were found to be very well demarcated with high piles of stones at all the bends.

255. Observations for azimuth were taken at 227 traverse stations. Connections have been made on 26 stations of the Great Trigonometrical Survey, furnishing the means of comparing the measured distances with 29 trigonometrical rays, which show the chaining to have an average error of $\frac{+3'4}{-2'7}$ feet per mile.

256. During the field season, the skeleton plots of 104 villages in Nagpur and 43 in Wardha, one for each *patwári* circle, were supplied to the officers conducting the respective settlement surveys, and the plots of all the remaining villages were furnished before the end of the recess. All the traverse plots of the Raipur district remaining over at the end of last recess were supplied to the Settlement Officer of that district during the field season.

257. The recess office of the party was inspected at Mussooree during October by the Deputy Surveyor-General in charge of the Revenue Branch, who reports the arrangements of Colonel Wilkins for the management of the party to be excellent, and the character of the records prepared in his office to be most satisfactory.*

JUBBULPORE AND SEONI DISTRICTS, CENTRAL PROVINCES.

No. 9 Party.

258. The traverse survey of the Damoh district having been completed, and the remaining area in the Jubbulpore district not affording sufficient employment for the entire establishment of this party, a part of the Seoni district was assigned to it by transfer from No. 11 Party. The party moved out from its recess quarters at Jubbulpore on 25th October 1887 and remained in the field until 1st May 1888, when it returned for recess to Jubbulpore.

Personnel.

Mr. G. H. Cooke, Officiating Deputy Superintendent, 3rd grade, in charge.
Mr. F. Grant, Surveyor, 1st grade, in charge, from 2nd August 1888.
Mr. J. Todd, Surveyor, 2nd grade.
Mr. H. Dowman, Surveyor, 3rd grade.
Mr. A. George, Assistant Surveyor, 2nd grade.
Mr. A. Ewing, ditto ditto.
36 Sub-Surveyors and others.

259. The nature of the operations has been the same as during the two previous seasons, *viz.*, a simple traverse survey along village boundaries, with sub-traverse lines about 30 chains apart dividing the village polygon into conveniently sized blocks, all designed to furnish a suitable framework for the measurements of the fields by *patwáris*. The permanent marks at the tri-junctions of village boundaries have invariably been adopted for traverse stations, and for other stations where permanent boundary marks were not available, stone prisms have been embedded. In all, 46,023 prisms have been put down at the cost of 2 annas 1 pie each, or R2-1-4 per square mile, the average number of special marks per square mile being 16.

260. The following statement shows the out-turn for each district:—

Districts.	Number of villages.	Number of traverse stations.	Area in square miles.
Jubbulpore	1,002	36,962	1,996
Seoni	660	18,374	920
Total	1,662	55,336	2,916

* Colonel Wilkins reports very favourably of Messrs. H. E. T. Keelan and O. D. Smart, and highly commends Mr. G. Vander Beek. Mr. W. J. Baker is said to be a promising assistant. The following members of the native establishment are reported to be deserving of mention, *viz.*: Bhagobutty Churn Chuckrabutty, Kedarnath, Mahomed Zakaria, Allahadad Khan, Dharonidhar, Rameshardial, and Audhar Chander Mukerjee.

261. The angular work was checked by 286 observations for azimuth, which gives one observation to every 10 square miles of country. Connections were made on 16 stations of the Great Trigonometrical Survey, by which comparisons have been made between the chain and triangulation distances of 16 rays, showing an average error in the chaining of 5·1 feet per mile, which is higher than the error of last year, and is owing to very difficult ground in some parts of the Seoni district.

262. In the Seoni district, where a considerable number of Forest Reserves had been formed at the time of the last settlement by the exclusion of excessive waste lands from the village areas, investigations have been made by comparing the maps of the boundaries of the reserves as now demarcated with the maps of the former survey, in order to ascertain whether the boundaries as now demarcated are the same as were originally laid down. All discrepancies which have been elicited by the comparisons have been brought to the notice of the Deputy Commissioner of the district.

263. The traverse plots of the villages of the Jubbulpore and Damoh districts which were standing over at the end of last recess were all furnished to the settlement authorities during the field season. With very few exceptions, all the plots of the Jubbulpore and Seoni districts had been furnished by the end of the recess.

264. The traverse survey of the Jubbulpore district has now been completed, and the portion of the Seoni district which was assigned to this party has also been finished. The party has therefore been transferred, under the requisition of the Commissioner of Settlements and Agriculture, for traverse survey operations, to the Chanda and Bhandara districts.

265. The recess office of the party at Jubbulpore was inspected by the Deputy Surveyor-General during July. The state of the records was found to be very satisfactory, reflecting much credit on the careful management of Mr. G. H. Cooke. In the absence of Mr. Cooke on three months' leave during the recess, the charge of the party was entrusted to Mr. F. Grant, Surveyor, of No. 2 Party, who carried on the office duties to the entire satisfaction of the Deputy Surveyor-General.*

SEONI AND CHHINDWARA DISTRICTS, CENTRAL PROVINCES.

No. 11 Party.

266. This party, under Colonel D. C. Andrew, resumed field operations in the Seoni and Chhindwara districts on 1st November 1887. A portion of the Seoni district had been transferred to No. 9 Party working in the Jubbulpore district in order to furnish it with a sufficient area to employ its establishments and with the object of reducing the area for survey by No. 11 Party on the expectation that both the Seoni and Chhindwara districts might be completed during the season. The Seoni district has been finished; but the difficult country met with in Chhindwara greatly retarded the survey: there were also delays through the demarcation of the village boundaries being imperfect; and the forest blocks, notwithstanding their size, which reduced the amount of the interior sub-traversing, did not afford the relief to the village traversing which had been expected, their boundaries being found to be situated in most intricate ground, and thus about 560 square

Personnel.

Lieutenant-Colonel D. C. Andrew, Deputy Superintendent, 2nd grade, in charge up to 31st August 1888.
Mr. W. H. Patterson, Officiating Deputy Superintendent, 4th grade, in charge from 1st September 1888.
Mr. W. A. Wilson, Surveyor, 2nd grade.
„ J. Newland, Surveyor, 4th grade, from 20th August 1888.
„ J. Hickie, Assistant Surveyor, 1st grade.
„ P. White, do. do.
„ C. George, do. 2nd grade.
44 Sub-Surveyors and others.

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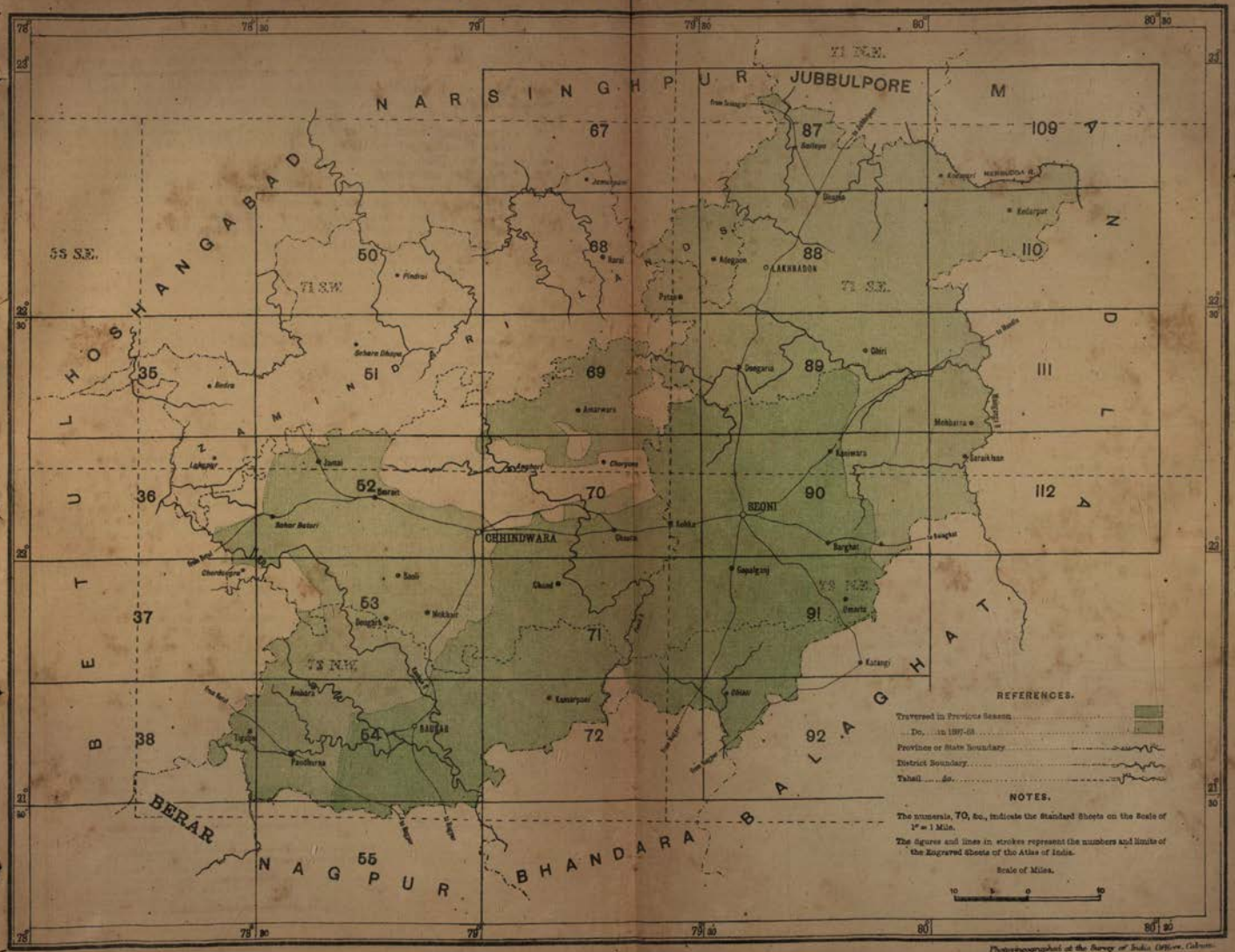
* Mr. Cooke reports favourably of all the European officers of the party, *viz.*, Messrs. Todd, Dowman, George, and Ewing.

Of the native establishment, he specially commends Lall Mohun Gungopadhaya, Tara Prosonno Roy, Manohar Daji, and Kesho Vaijnath, and reports well of Upendra Nath Mukerjee, Gopal Seetaram, Behari Lall, Faida Ali, Irfan Ali, Mahadeo Daji, Ganpat Pai, Murad Ali, Murli Manohar, and Piari Lall.

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTS. SEONI & CHHINDWARA. Nos. 9 & 11 PARTIES.



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January 1899.

Photozincographed at the Survey of India Office, Calcutta.

miles remain over in this district for next season. The party remained in the field until 6th June and then returned to its recess quarters at Poona. On Colonel Andrew being granted furlough to Europe from 1st September, Mr. W. H. Patterson was appointed to the charge of the party.

267. The operations were of a similar nature to those of the previous season and such as are being carried out in other districts of the Central Provinces for the purpose of furnishing skeleton traverse plots to be used for the settlement surveys of the fields by *patwáris*. Briefly it may be stated that, under the prescribed plan, the traverse lines have been kept close to the boundary pillars so as to provide for the survey of the actual boundaries being readily done by the *patwáris*, and in large villages the cultivated lands have either been sub-divided into conveniently sized traverse blocks, or, where there are waste lands within the villages, these have been blocked off by sub-traverse lines from the cultivation.

268. In the Seoni and Chhindwara districts, the stones to the number of 21,195 for marking the theodolite stations have been provided by the village *málguzárs*, who also gave assistance in transporting the same to the stations and in the embedding of them, for which final operation, however, the survey staff was responsible. The out-turn of field work is tabulated in the following statement:—

District.	Number of villages.	Number of sub-traverses.	Number of traverse stations.	Area, square miles.	Remarks.
Seoni	483	820	20,025	1,071	Besides, the villages herein stated, there are 154 Forest blocks.
Chhindwara	631	1,280	18,095	1,433	
Total .	1,114	2,100	38,120	2,504	

Observations for azimuth have been taken at 269 traverse stations to regulate the angular work, and the traverse survey has been connected with 6 stations of the Great Trigonometrical Survey.

269. Although the survey has been completed for the villages shown in the table as above, the office work remains incomplete for 114 villages in Seoni and 331 villages in Chhindwara, owing to the failure of the mathematical proof of the polygons through faulty measurements in difficult rocky ground, and the traverse plots of these villages cannot be furnished until re-measurements have been taken at the beginning of next season. Skeleton plots of all the villages surveyed in two seasons, excepting those mentioned above, have been furnished to the district authorities.

270. During the ensuing season, one section of the party will in the first instance proceed to the Chhindwara district to complete the survey there and to rectify the inaccurate polygons in Seoni, and afterwards it will join the second section in the Nimar district which has been assigned to the party for traverse survey and which the second section will at first undertake alone, having proceeded there direct from recess quarters at Poona.

271. The recess office of the party was inspected at Poona during July by the Deputy Surveyor-General in charge of the Revenue Branch, who reports that he found the office computations in a backward state, and that he gave the necessary instructions for the work to be prosecuted more systematically. The necessity for keeping back the plotting of the faulty polygons was recognized during the inspection.*

* Colonel Andrew reported favourably on the field work done by Mr. P. White.

Mr. Patterson, who prepared the Report, mentions the good services in office of Mr. J. Newland who joined the party during the recess season.

Mr. Patterson reports favourably of the following members of the native establishment, *viz.*:—sub-surveyors Shadi Lall, Seeta Ram, Ori Pandey, Lall Bahadur, Prithiram Gharuk and Matapalat; computers Balwant Vishnu Patwardhan, Bhagwandin Tirbedi, Narayan Timapah, and Peter Thomas; and Hospital Assistant Mohib Ali who aided in the office computations.

SAUGOR AND NARSINGHPUR DISTRICTS, CENTRAL PROVINCES.

No. 12 Party.

272. This party, which had recessed at Saugor, resumed field operations in the Saugor and Narsinghpur districts on 1st November, on which date the field establishments of the previous season were recalled from leave, and additional establishments were entertained so as to provide for an increased out-turn. The field season continued up to the end of May, when the office establishment was again taken to Saugor for recess duties.

Personnel.

Mr. E. J. Jackson, Officiating Deputy Superintendent, 3rd grade, in charge.
„ A. J. Gibson, Surveyor, 2nd grade, up to 21st October 1887.
„ W. R. Vyall, Surveyor, 3rd grade, up to 15th May 1888.
„ J. T. U. Coxen, Surveyor, 4th grade.
„ G. T. Hall, Assistant Surveyor, 1st grade.
„ H. A. Charrier, Assistant Surveyor, 3rd grade.
57 Sub-Surveyors and others.

273. In the beginning of the field season immediate attention was given to completing the villages of the previous season in which revisions of the measurements were required, and the office computations were all finished and plots furnished for the settlement survey by the end of December.

274. A tract of hilly country, almost mountainous in character and extremely difficult for chain traversing was met with in the Narsinghpur district overlooking the Nerbudda valley. Here, besides the obstructions due to the precipitous ground, and the scarcity of water which necessitated long distances to be travelled daily by the traversing squads, a severe type of fever broke out, from which at one time fifty men were incapacitated and four deaths occurred. The survey of this tract, where the traversing squads endured many hardships, was not finished until the end of June. In the Saugor district, though much rocky ground was met with, the conditions of the country for chain traversing were generally favourable.

275. The laying down of permanent marks at all traverse stations has again been carried out under extensive arrangements for quarrying and transporting stones of a uniform size, of which 35,091 have been embedded. At the same time, existing boundary stones were utilized as station marks where found to be suitable, and a considerable number of stations were fixed by marks being cut on the solid rock. For all stones embedded or marks fixed, acknowledgments have been taken from the headmen of villages as a precautionary measure to ensure the preservation of the stations. Sketch maps showing the positions of the stations have at the same time been delivered to the headmen to guide them to the stations placed under their charge. Great care was taken to place the traverse stations exactly on the village boundary lines (excepting where streams form the boundaries) and to keep the traverse lines within a maximum distance of two chains from the intermediate bends of the boundaries. Sub-traverses blocking out large villages and separating cultivation from jungle have been measured on the average of one and a half sub-traverse for each village.

276. The out-turn of the season is shown in the following statement :—

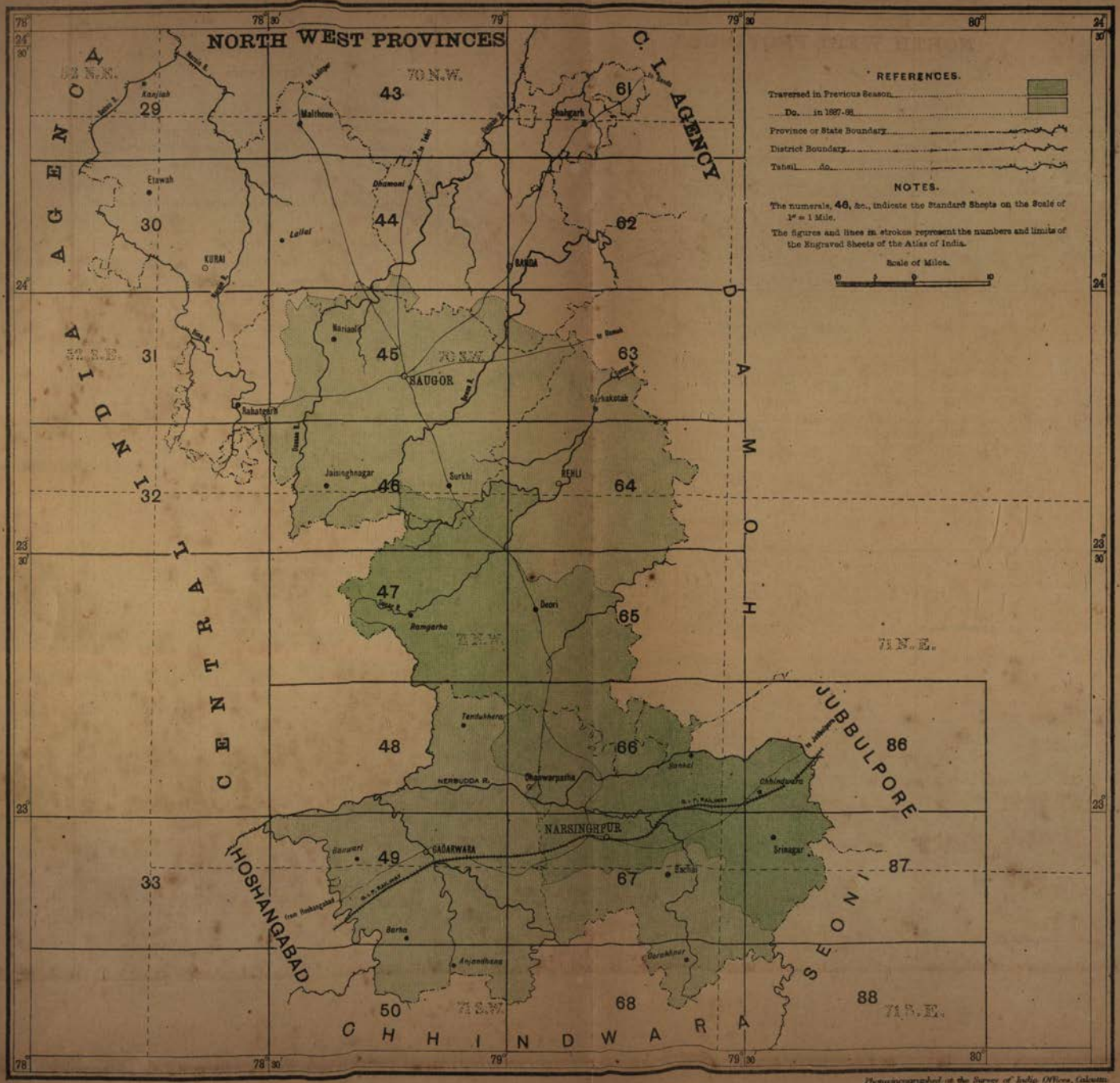
Districts.	Number of villages.	Number of sub-traverses.	Number of stations.	Area, square miles.	Remarks.
Saugor . .	711	897	22,720	1,471	In addition to the villages herein returned, 65 forest blocks intermingled with the villages have been surveyed in Saugor and 23 in Narsinghpur.
Narsinghpur .	553	945	20,083	1,132	
Total .	1,264	1,842	42,803	2,603	

277. The out-turn of area shows an increase of 1,048 square miles over the out-turn of last season. Observations for azimuth have been taken at 196 stations, and 18 observations taken by No. 9 Party on the common boundary of

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTS. SAUGOR AND NARSINGHPUR.

No. 12 PARTY.



Photozincographed at the Survey of India Offices, Calcutta.

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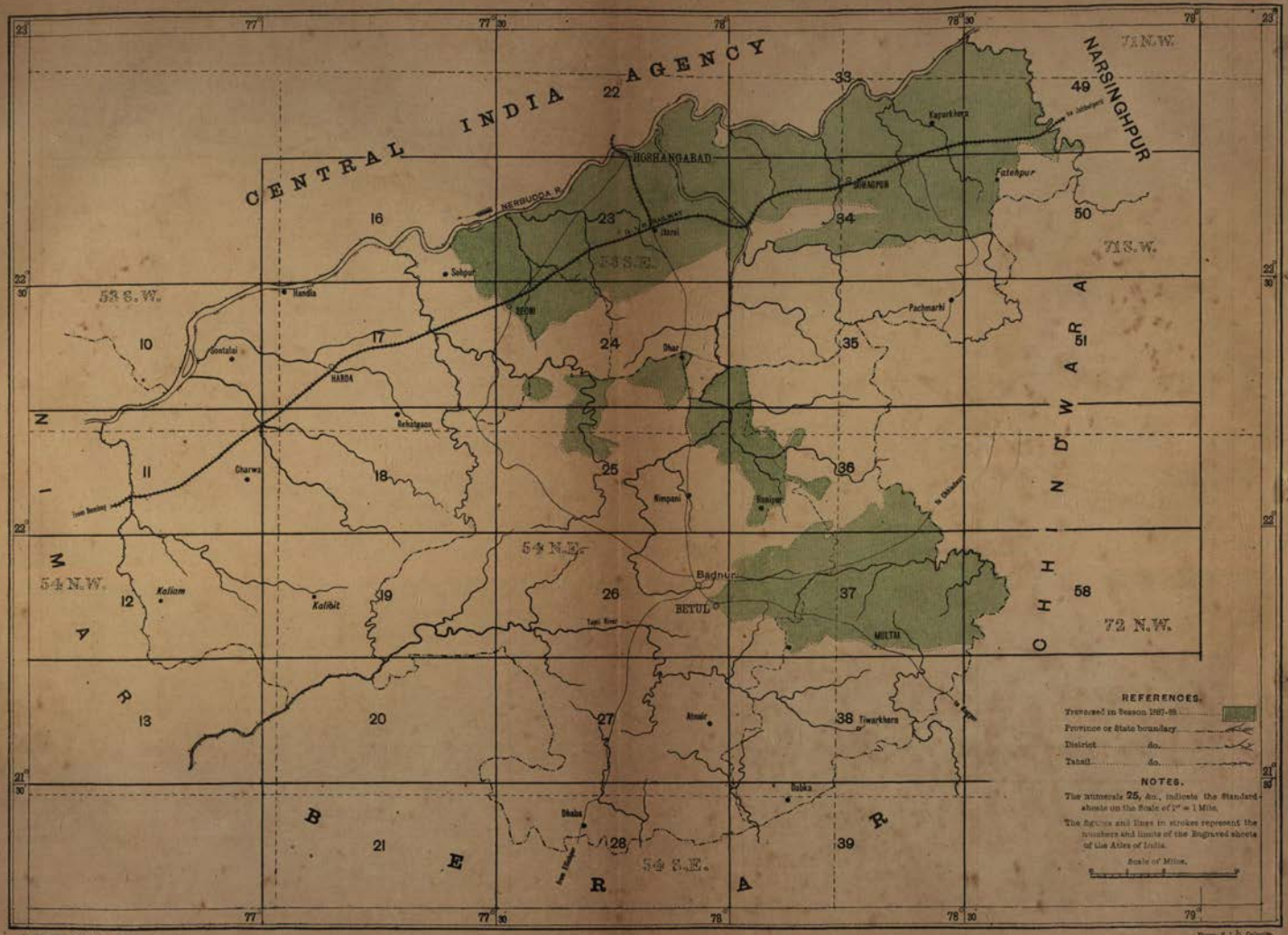
1888

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTS. HOSHANGABAD & BETUL.

No. 13 PARTY.



the Damoh district have been adopted for the Saugor traverses. Connections have been made on 9 Hill stations of the Great Trigonometrical Survey.

278. During the field season, the plots of 159 villages in district Saugor and 171 in district Narsinghpur were furnished to the settlement surveyors according to special requisitions where the field surveys by *patwáris* were desired to be instituted; and by 31st October all the remaining plots had been furnished, excepting for 4 villages of Saugor and for 16 villages of Narsinghpur, in which revisions of chain measurements were required.

279. During the recess, investigations were carried out by Mr. Jackson, at the request of the Deputy Commissioner of Saugor, to ascertain, by comparison of the maps of the boundaries of the forest reserves according to the present survey with the maps of the former survey, whether the boundaries had been rightly demarcated. The results of the investigations showed that the original boundaries had been very well preserved, the agreement between the maps being generally excellent.

280. The recess office of the party was inspected at Saugor during July by the Deputy Surveyor-General in charge of the Revenue Branch, who reports the character of the records prepared by the party to be very good; also, that he is well satisfied with the state of efficiency to which Mr. Jackson has raised the establishment as evidenced by the work connected with a largely increased area being completed in excellent time.*

DISTRICTS HOSHANGABAD AND BETUL, CENTRAL PROVINCES.

No. 13 Party.

281. This party, which has hitherto been of half strength while employed on the traverse survey of district Sambalpur, has been raised to full strength, so that it might undertake the traverse survey of two districts, *viz.*, Hoshangabad and Betul, which were next in order for survey in the prescribed programme for the traversing of all the districts in the Central Provinces. The additional members required for the native establishment were trained at Nagpur during the recess season of 1887 and consisted mainly of men of the North-West Provinces; though a few local men were obtained, some of whom were suitable for office and some for field employment. The additional European officers, transferred from other parties, were sent to join when the party took the field.

Personnel.

Mr. A. D'Souza, Officiating Deputy Superintendent, 4th grade, in charge.
Mr. P. A. G. Cowley, Surveyor, 1st grade, on medical leave up to 23rd November 1887.
Mr. A. J. Gibson, Surveyor, 2nd grade, from 1st November 1887.
Mr. D. A. King, Surveyor, 4th grade, on medical leave from 20th December 1887.
Mr. C. W. Wilson, Assistant Surveyor, 1st grade, from 1st December 1887.
Mr. C. W. F. Seyers, Assistant Surveyor, 1st grade.
Mr. T. W. Babonau, Assistant Surveyor, 2nd grade.
37 Sub-Surveyors and others.

Temporary Establishment.

2 Sub-Surveyors, &c.

282. Both sections of the party, as detailed for the respective districts, reached their ground before the end of October, the Betul section having proceeded direct from Nagpur by route march and the Hoshangabad section by railway. At first, the progress made by the newly entertained sub-surveyors was slow, especially in Betul, where the country was difficult on account of its rugged character. There were also delays through severe sickness during March among the squads working on the margins of forest tracts. Consequently, the field season was protracted to an unusual length in an endeavour to finish the projected area for the year, which, although the party worked on until the 6th June, was not in the end fully accomplished, the defect being in the Betul district, owing to the difficult country and to the sickness. In Hoshangabad the programme was exceeded by 100 square miles.

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* In his Report, Mr. Jackson mentions with regret the death of Mr. W. R. Vyall, which occurred on 28th August 1888, at Rangoon, where he had proceeded on sick leave.

Mr. Jackson commends Mr. Hall for good work and for the efficient supervision he exercised over the sub-surveyors working under him in a difficult country.

The following members of the native establishment are specially commended, *viz.*:—sub-surveyors Narsoo dinker, Jamaludin, and Balkishen; computers Rhidoy Chunder Dass, Jogendra Nath, and Abdul Gani; draftsmen Abdul Wahid and Tufail Ahmed.

283. The out-turn of work accomplished in both districts is shown in the following statement:—

Districts.	Number of villages.	Number of sub-traverses.	Number of traverse stations.	Area in square miles.	Number of traverse sheets.
Hoshangabad	757	1,307	18,425	1,398	1,399
Betul	455	736	18,628	960	909
Total .	1,212	2,043	37,053	2,358	2,308

284. The nature of the operations is the same as that which is in force for all other districts under traverse survey in the Central Provinces, which, as explained in previous reports, is a system of skeleton traversing of village boundaries, designed to form the basis of a cadastral survey to be done by *patwáris*, and, besides the traverse stations on the boundaries, other stations are fixed in large villages to furnish a complete frame-work for the survey of the in-lying fields.

285. All traverse stations have been placed on permanent marks, many of which are the mark-stones found to be existing as boundary-marks, but where the boundaries had been marked in a temporary manner special stones were procured and embedded.

286. The angular measurements were checked and regulated by 228 sets of observations for azimuth, 119 in Hoshangabad and 109 in Betul. Connections were made on 18 stations of the Great Trigonometrical Survey, which furnished 17 tests with trigonometrical distances, showing that the traverse measurements have an average error of 2·42 feet per mile in Hoshangabad and 9·8 feet in Betul, the larger error shown in the latter district being due to the traverse lines having to be taken in accord with the village boundaries over very rugged ground. The office computations have been completed, and traverse plots have been furnished to the district officers, except for a few villages of Betul, in country extremely difficult for accurate chaining, where the measurements require to be revised.

287. The recess office of the party, which had been transferred from Nagpur to Poona, was inspected during July by the Deputy Surveyor-General in charge of the Revenue Branch, who reports that he was highly satisfied with the character of the records, and who represents that the present efficient state of the native establishment, which is largely composed of new members, reflects great credit on Mr. D'Souza's management.*

GEODETIC.

ELECTRO-TELEGRAPHIC LONGITUDE OPERATIONS.

Nos. 22 and 23 Parties, Astronomical.

288. The services of two officers being available for astronomical work during the season under review, the operations for the electro-telegraphic determination of arcs of longitude were resumed in Southern India. Those selected for measurement form part of the general scheme for extending a network of longitudinal arcs over the whole of India, and include two which had been measured experimentally in the season 1872-73, when the longitude equipment was first

Personnel.

No. 22 Party.
Lieut.-Colonel W. J. Heaviside, R.E., Deputy Superintendent, 2nd grade, in charge.
Dhondo Balwant Joshi, Sub-Surveyor.

No. 23 Party.
Lieut.-Colonel G. Strahan, R.E., Deputy Superintendent, 1st grade, in charge.
Harsahai, Recorder.

* Mr. D'Souza reports very favourably on the services rendered by Mr. A. J. Gibson, who had many difficulties when in charge of the Betul section. He also makes favourable mention of Mr. C. W. Wilson, who had charge of the computations in district Hoshangabad, and likewise commends the assistants, Messrs. Seyers and Babonau. The following members of the native establishment are reported to have performed their respective duties most creditably, viz:—Hidayatulla, Rajdhari Lall, Koylash Chunder, Habibulla, Niladhar, Mohamed Hosein, Boith Ram, Abdul Kholik, Changa Khan, Ramcharan, Mohamed Yusuf, Dalmir Khan, and the Hospital Assistant Jairam Dowlut.

introduced into India and the observers employed were unpractised in its use and when parts of the apparatus were somewhat ill-adapted to the purposes for which they had been designed. The difficulties met with by the observers on that occasion are entered into in some detail in General Walker's report for that year, and in extracts from Captain Campbell's report in the appendix, which led to the final rejection of those two arcs.

289. During the present season the programme for measuring the other arcs of Southern India afforded a convenient opportunity for the revision of these, as well as for the completion of another which had been left in an unfinished state. These three arcs in addition to four new ones were therefore included in the programme which stood as follows and was worked out in its entirety :—

1. Madras —Bangalore.
2. Bangalore—Nagarkoil.
3. Madras — „ .
4. Nagarkoil —Mangalore.
5. Madras —Mangalore.
6. Bellary — „
7. Mangalore—Bombay.

Nos. 1 and 5 being the two arcs which were revised, and No. 7 the arc which had been left incomplete in 1872-73.

290. There is no special novelty to be noticed in the observations that were made; the apparatus has been now in use for so many years that the best methods of using it had become quite familiar to the observers, Colonels Strahan and Heaviside, and no departure from the fixed procedure was deemed advisable. Constant vigilance to guard against the intrusion of minute errors is imperative, and due caution in this respect has been exercised.

291. In several previous reports the existence of errors has been noticed and their causes and remedies discussed, but it should be borne in mind that these so-called errors are intrinsically so minute as to be of no consideration whatever, except in a scientific investigation of so refined a nature as that for which these measurements are undertaken. It would be too much to say that they are entirely unimportant in this particular enquiry, but still the reader should guard against any hasty conclusion that the work is seriously vitiated by them. They are for the most part deviations from mean results, which results must necessarily approximate very closely to the truth, differing only by magnitudes which lie near the limits of human conception. Their investigation is extremely interesting and may not improbably lead to further contrivances for improving the construction of transit instruments. Much care and thought has been spent upon them in previous years, and some further experiments were made during the present year by Colonel Strahan in hopes of throwing more light upon their cause. These experiments are detailed in his report, extracts from which are given in the appendix. They were for the most part directed towards ascertaining whether the mere elevating or depressing of the telescope affected in any way its position in the meridian, or in other words whether there is unequal flexure in the two halves of the transit axes acting at different altitudes in an uncertain and variable way, for which no law has been yet traced. The method employed was by comparison of observations on a star's transit by direct vision with those obtained from it by reflection from the surface of mercury. It is obvious that, although the elevation of the telescope differs largely in the two cases, yet that as the reflection takes place in a vertical plane, the times of transit should be identical in the two positions when the instrumental correction for dislevelment has been applied. It is satisfactory to note that Colonel Strahan found from his experiments that the times of transit by direct and reflected vision differed by only 0·05 of a second. The telescope he used was that known as No. 2, and has always been considered the less trustworthy of the two. No opportunity offered for experiments with No. 1 Transit during the present season.

292. This season's measurements afford additional evidence towards establishing a curious geodetic fact which now rests upon so strong a basis as to be practically proved, *viz.*, the deviation of the plumb line round the coasts of India in the direction of the sea. This had already been brought to light by the electro-telegraphic longitude operations when Volume IX of the operations of the Great Trigonometrical Survey of India was published, and the reader is referred to page xvii of the preface to that volume. The conclusion is based on the fact that, in every case of longitudinal arcs running east or west with one or both stations

on the coast, the astronomical arc is less than the geodetic one, thus showing a displacement of the zenith in the opposite direction from the sea. It would be premature at this stage of the investigation to give numerical results, as all the arcs have yet to be reduced together in one operation, but the tendency is too obvious to be overlooked.

293. The revision of the two arcs above alluded to, *viz.*, Madras-Bangalore and Madras-Mangalore, furnishes values exceeding the experimental values in 1872-73 by 0·23 and 0·29 of a second respectively, which is perhaps as near an agreement as could be expected when the circumstances under which the earlier measurements were made are taken into account. The arc Mangalore-Bombay shows, as might have been expected, a far closer agreement, as it was measured after the apparatus had been in use nearly three years and the observers had been well practised in its use. The former value is oh. 8m. 7·369s. deduced from four nights' measurement by Colonels Campbell and Heaviside, and the latter oh. 8m. 7.392s. from two nights' measurement by Colonels Strahan and Heaviside during the present season, thus showing a difference of only 0·023 of a second.

294. The circuit errors this season show a diminution and are perhaps as small as can be expected, but the daily and the pivot differences still seem somewhat larger than desirable. A minute analysis of one arc, Bangalore-Nagarkoil (selected at random), was made to ascertain between what limits the length of the arc lay, when a separate value was computed from the observations of each star on each night. In the following table the stars are given in order of declination from north to south in the first column; in the second are given the declinations to the nearest minute. In the next six columns the corresponding values of the arc of longitude for each star on each night are shown, as well as the pivot positions of the telescopes in the headings of the several columns. The means for all the stars for each night are taken out at the bottom of the columns, and the mean for each star for all the nights in the right hand column, stars north and south of the zenith being kept separate. The corrections for personal equation, retardation, and pen equation have been previously applied to each observation. The arc values number in all 182, ranging from 35·42 to 35·79 seconds, the mean being 35·616 seconds with a probable error of ± 0·004 second.

Arc—Bangalore-Nagarkoil; Tel. No. 1 E. Bangalore, No. 2 W. Nagarkoil.

B. A. C. Name of Star.	Declination.	Jan. 15th No. 1. I. P. W * No. 2. I. P. W.	Jan. 16th No. 1. I. P. E.* No. 2. I. P. W.	Jan. 17th No. 1. I P. E. No. 2. I. P. E.	Jan. 18th No. 1. I. P. W. No. 2. I. P. E.	Jan. 19th No. 1. I. P. W. No. 2. I. P. W.	Jan. 20th No. 1. I. P. W. No. 2. I. P. W.	Mean for each Star.
2338	+39°—30′	35ˢ·75	35ˢ·56	35ˢ·67	35ˢ·68	35ˢ·70	ˢ	35ˢ·672
6. Cancri	+28 —6	·65	·58	·68	·72	·67	35·45	·625
2442	+28 —?	·79	·58	·61	·64	·74	·56	·653
2688	+27 —51	·74	·69	·70	·73	·73	·56	·692
2278	+26 —4	·74	·68	...	·69	·71	·57	·678
2549	+26 —1	·69	·68	·54	·70	·72	·56	·648
2299	+24 —23	·78	·67	·70	·68	·66	·55	·673
8. Gem	+22 —11	·65	·54	·65	·70	·76	·60	·650
2455	+21 —46	·75	·57	...	·65	·72	·53	·644
2423	+20 —39	·73	·61	·59	·71	·67	·60	·652
2556	+20 —35	·72	·69	·59	·71	·70	·53	·657
2632	+20 —11	·73	·66	...	·67	·75	·59	·680
2558	+18 —47	·70	·66	·62	·72	·71	·55	·660
2519	+17 —56	·63	·61	·48	·67	·73	·59	·618
2330	+16 —7	·68	·60	·59	·64	·72	...	·646
2639	+16 —5	·64	·68	·62	·74	·65	·47	·633
	Means	35·711	35·625	35·618	35·691	35·709	35·551	35·655
2503	+ 6 —7	35·64	35·54	35·55	35·61	35·67	...	35·602
2358	— 0 —18	·61	·56	·48	·64	·63	35·50	·570
2513	— 3 —52	·63	·52	·52	·64	·63	...	·588
2348	— 4 —4	·61	·51	...	·60	·67	·46	·570
2307	— 4 —5	·64	·61	·59	·59	·67	·48	·597

* I. P. W.=illuminated pivot west, and I. P. E.=illuminated pivot east.

Arc—Bangalore-Nagarkoil; Tel. No. 1 E. Bangalore, No. 2 W. Nagarkoil. —continued.

B. A. C. Name of Star.	Declination.	Jan. 15th No. 1. I. P. W. No. 2. I. P. W.	Jan. 16th No. 1. I. P. E. No. 2. I. P. W.	Jan. 17th No. 1. I. P. E. No. 2. I. P. E.	Jan. 18th No. 1. I. P. W. No. 2. I. P. E.	Jan. 19th No. 1. I. P. W. No. 2. I. P. W.	Jan. 20th No. 1. I. P. E. No. 2. I. P. W.	Mean for each Star.
2437	— 5 —46	·63	·60	·57	·65	·66	·50	·602
2542	— 9 —17	·66	·53	·55	·53	·63	·46	·560
2319	—15 —28	·55	·60	·54	·54	·63	·45	·555
2666	—18 —5	·58	·60	·60	·56	·64	·49	·578
2632	—22 —35	·67	·51	·57	·51	·70	·47	·572
2418	—24 —45	·63	·57	·62	·57	·60	·48	·578
2531	—26 —33	·68	·48	·52	·47	·60	·49	·540
2405	—27 —41	·63	·62	·51	·60	·61	·44	·568
2708	—29 —25	·65	...	·66	·63	·62	·56	·624
2655	—30 —2	·67	·50	·62	·49	...	·53	·562
2399	—30 —29	·56	·67	·62	·58	·65	·42	·583
	Means	35·628	35·561	35·568	35·576	35·642	35·481	35·578
Daily	means	35·670	35·596	35·592	35·634	35·676	35·516	35·616 p. e.± ·004

295. This result seems certainly satisfactory, but one prominent fact immediately presents itself, for which as yet no explanation is forthcoming, *viz.*, that the value of the arc as determined by stars north of the zenith exceeds its value by stars south of the zenith by 0·077 of a second. This excess is persistent, and in the six daily means there is not one single exception to the law.

We may also deduce from the table that:—

With Telescope No. 1. I. P. W. } arc of longitude = 35ˢ·673
„ „ 2. I. P. W. }

„ „ 1. I. P. E. }
„ „ 2. I. P. W. } „ „ = 35·556

„ „ 1. I. P. E. }
„ „ 2. I. P. E. } „ „ = 35·592

„ „ 1. I. P. W. }
„ „ 2. I. P. E. } „ „ = 35·634

These figures show that the so-called pivot differences have diminished on comparison with those of some previous years. The correction for retardation for each night in the table was furnished by a consideration of the measurements on that night, and not from a mean of the whole series.

While on the subject of retardation, it should be noticed that in the Annual Report for 1886-87, paragraph 265, a remark occurs that on one night of the observations on the Agra-Mooltan arc the retardation was found to be 0·4 of a second. This is due to an oversight, as the quantity was obtained by comparing two values which were not strictly comparable, for some corrections which affected the result had not been applied. Retardation may be defined as being the excess of an arc of longitude as determined by a clock at the western terminus, over the same arc as determined by a clock at the eastern terminus—when telescopes, chronographs, batteries, &c., remain in precisely the same state during both measurements. In the report of 1886-87, it was overlooked in the great mass of figures dealt with, that this condition did not hold, as a change had been made in telescope No. 1 from I. P. E. to I. P. W., thus introducing and mixing up with the retardation the effect known as pivot error. The concluding sentence of that paragraph need not therefore be taken into consideration in any future discussion on the subject of retardation.

296. There are in the possession of this department two transit instruments of the Russian pattern which are of much lighter construction than those at present in use in India, and in view of their possible employment in future, some experiments were carried on at Mussooree during the recess season to ascertain whether sufficient reliance could be placed on their performances to justify their

adoption in the electro-telegraphic longitude work. The conclusion arrived at is that they are in many ways suitable and of good solid construction, but that certain simple alterations are necessary, especially in that one known as No. 2, before they can be used with confidence in work calling for such extreme accuracy. Steps have already been taken to have these alterations carried out in the Mathematical Instrument Office in Calcutta.

297. Colonels Strahan and Heaviside both acknowledge the courtesy of Messrs. Pogson and Chambers, the Astronomers in charge of the Madras and Bombay observatories respectively, and of the various Telegraph officials with whom their duties brought them in contact.*

TIDAL AND LEVELLING OPERATIONS.

No. 25 Party.

Personnel.

Major M. W. Rogers, R.E., Deputy Superintendent, 3rd grade, in charge from 18th May 1888.
Major J. Hill, R.E., Deputy Superintendent, 3rd grade, in charge up to 17th May 1888.
Mr. J. Eccles, M.A., Officiating Deputy Superintendent, 4th grade, attached to the party from 1st November 1887.
Mr. G. Belcham, Surveyor, 3rd grade.
„ E. J. Connor, Surveyor, 4th grade.
„ J. Bond, Surveyor, 4th grade, from 20th August 1888.
„ G. D. Cusson, Assistant Surveyor, 1st grade, and 16 Recorders and Computers.
Sub-Surveyors Narsing Das and Dhondu Venayek.

277. The direction of these operations remained in the hands of Major Hill until the 18th May 1888, when that officer took furlough to England and was relieved by Major M. W. Rogers.

Tidal Operations.

298. The recording of the tidal curves by the self-registering tide gauges, their reduction and the publication of the predicted heights have been continued as usual during the past year at 18 stations, *viz.*, *Aden*, *Kurrachee*, Bhávnagar, *Bombay*, Mormugáo, Cochin, Colombo, Galle, Tuticorin, Negapatam, *Madras*, Cocanada, *Kidderpore*, Chittagong, Akyab, Elephant Point, *Rangoon* and *Port Blair*. The eleven tidal stations, the names of which are not italicised, are minor stations at which as a rule only five years' registrations are required, after the completion of which the instruments are removed. The seven others are permanent stations, where tidal observations have to be continued until the work at all the minor stations is completed.

299. Since the date of the last report, work has ceased at two tidal stations, *viz.*, Negapatam, where five years' observations were completed on the 30th April 1888, and Elephant Point, where the observatory was reported unsafe, so work was closed on the 18th June after four and a half years' observations had been completed, as it was not judged desirable to incur the expense and delay of erecting a new observatory to secure the half year's work which was deficient. Two new tidal observatories have been established during the year under report—one at Tuticorin, which was started on the 1st June with the instruments that were removed from Negapatam; and the second at the entrance to Prince's dock at Bombay. The gauge at the latter place is by Légé and is of a different pattern from any of the others in use in India: it was started on the 22nd September 1888.

300. Thus, since the resumption of the systematic tidal observations in 1877, observations have been taken at 28 tidal observatories, of which eleven have been closed on the completion of their registrations and seventeen are now in operation. Arrangements are being made to start an observatory at Mergui in February 1889, which will utilize one of the two sets of instruments now unemployed. Three other sets will be set free in the next year, but no steps have as yet been taken to provide work for them. Diamond Island in Burma, Trincomalee in Ceylon, and Singapore seem to be places for which Tide Tables would be scientifically and practically useful.

301. All the observatories, with the exception of those at Aden and Kurrachee, have been inspected either by the officer in charge or by one of his

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* Colonel Strahan brings to notice the services of Mr. Bond for the satisfactory execution of the work ntrusted to him, and speaks highly of the diligence of his Observatory Assistant, Harsahai.

assistants. The detailed account of the working of each observatory will be found in the appendix: the registrations have been satisfactory and there have been but few failures; the clerks have performed their duties well, and the Port Officers at the various tidal stations have been very helpful.

302. The reductions of the observations have been carried on steadily during the year, a larger amount having been completed than in any previous year. The observations for one year at fourteen ports, for two years at one port, and for three years at another port were reduced—equivalent in all to the reduction of the observations at nineteen ports for one year.

303. The usual work in connection with the yearly issue of the Tide Tables for 1889 has been accomplished. These tables will contain predictions of heights and times of high and low water for twenty-eight ports, being one more than in the volume for 1888.

304. A commencement has also been made in the reduction of the meteorological records of the observatories. At present the computations are entirely tentative in order to determine the best method of reduction and the application of their results to the tides. These reductions have been undertaken by Mr. Eccles, whose mathematical attainments render him specially fitted for the work.

The results of the predictions for 1887 may be summarised as follows:—

Percentage of predictions within 15 minutes of actuals.

	High water per cent.	Low water per cent.
Open Coast Stations . . .	56	52
Riverain	71	71

Percentage of predictions within 8 inches in height of actuals.

	High water per cent.	Low water per cent.
Open Coast Stations . . .	98	98
Riverain	69	64

These figures, when compared with those of 1886, show a decided improvement in the predictions for the riverain ports, where they were at first very inaccurate, thereby proving that the care and labour expended by Mr. Roberts of the Nautical Almanac Office in correcting these results has not been expended in vain. As was explained in paragraph 281 of last year's report, the above figures are somewhat misleading as regards the height predictions, as a better idea of the correctness of the heights can be obtained from the table of average errors given in the appendix.

SPIRIT-LEVELLING OPERATIONS.

305. The levelling operations during the year under report were as under:—

Section I.—Madras to Vizagapatam *viâ* Nellore, Guntúr and Cocanada.

Section II.—At False Point, to connect the Marine Survey bench-marks with the main line of levels.

Section III.—From Chinsurah to Nuddea along the right bank of the Hooghly.

The total out-turn amounted to 597 miles of double levelling, in the course of which the heights of 591 permanent bench-marks and 10 stations of the Great Trigonometrical Survey have been finally determined. The apparent mean error generated in the levelling in the season's work was 0·0010 foot per mile. During six weeks a small extra party was employed on the levelling of Section III. The other two sections were done by the regular levelling detachment of the party whose total out-turn exceeded that of the last season by 95 miles.

306. Three more pairs of test bench-marks, for detection of the secular change of the relative level of land and sea, have been laid down in connection with the tidal stations of Cocanada, Vizagapatam, and False Point.

307. It is intended during the ensuing season to undertake a line of levels between Bangalore and Mangalore; and on the completion of this, to continue the main line of levels from the Bider base-line to meet the main line near Guntúr.*

* Major Rogers reports most favourably of Messrs. Belcham, Connor, and Cusson; the first two in the Tidal division, and the third in the Levelling section. Sub-Surveyors Narsing Das and Dhondu Venayek have also done very well, and generally the sub-surveyors and computers have given satisfaction.

GEOGRAPHICAL SURVEYS.

OPERATIONS IN UPPER BURMA.

NO. 21 PARTY.

308. During the year under report, the superintendence of the operations in Upper Burma has remained in the hands of Major Hobday. This party has taken the position of the one that was employed in the Nicobars during the previous year and is now numbered as one of the regular field parties.

Personnel.

Major J. R. Hobday, B.S.C., Deputy Superintendent, 4th grade, in charge.
Captain H. M. Jackson, R.E., Offg. Deputy Superintendent, 4th grade, up to 30th April 1888.
Lieutenant T. F. B. Renny-Tailyour, R.E., Assistant Superintendent, 2nd grade, from 1st April 1888.
Mr. A. G. Wyatt, Surveyor, 3rd grade.
„ F. Kitchen, „ 4th „
„ R. A. Gibson, Asst. Surveyor, 1st grade.
„ J. M. Kennedy, „ „ 2nd „
„ G. H. Powell, „ „ 3rd „ up to 27th May 1888.

Sub-Surveyors.

Sher Shah, Bapu Jadu, Faida Ali, Gobardhan Dass, Shiv Charan, Ali Nawaz Khan, and 3 others.

As in the previous season, the work consisted mainly of reconnaissance surveys, carried out in connection with the various military movements undertaken for the pacification of the country.

309. The large amount of map-compiling, which devolves on this party, required Major Hobday's special supervision and prevented his being absent from head-quarters at Mandalay for any long period. He was enabled, however, to extend the triangulation up the valley of the Irrawaddy from Mandalay to Bhamo, at both of which places he took astronomical observations for latitude with a 14-inch transit instrument, and previous to the starting of the Mogaung expedition, he accompanied the Deputy Commissioner, Major Adamson, from Bhamo through the upper defile of the Irrawaddy to Senbo, where he obtained additional data for basing the work to be done by the surveyors attached to that expedition. Major Hobday also accompanied many of the surveyors to assist them in starting their work on the various expeditions.

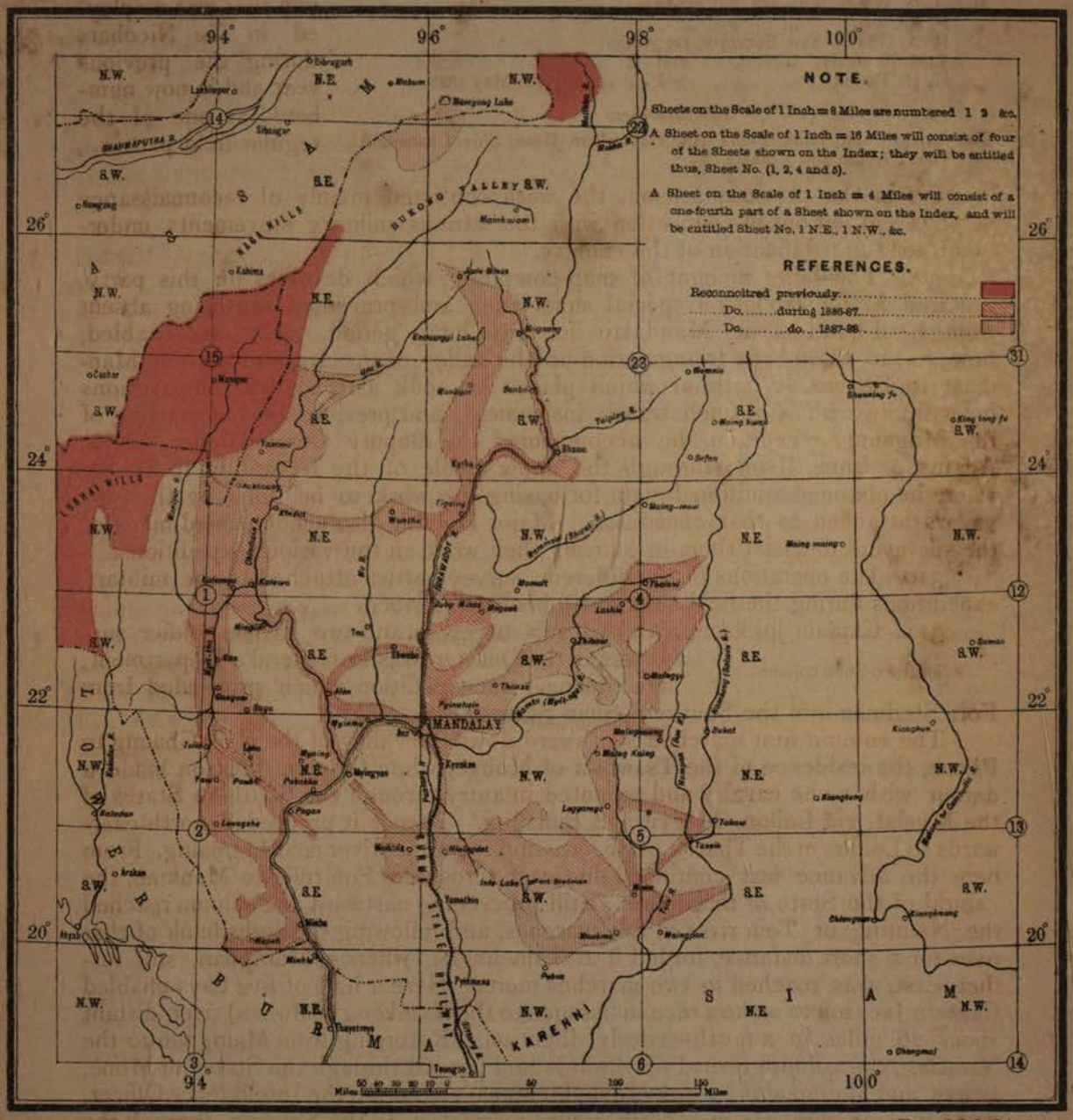
310. The operations of the different survey parties attached to the military expeditions during the field season will benow described.

311. Captain Jackson, with two sub-surveyors and two native soldier surveyors of the Quarter Master General's Department, accompanied the expedition which proceeded from Fort Stedman into the Southern Shan States.

Southern Shan column.

The column first marched southward down the valley of the Balu Chaung to Pekon, the residence of the Tsawbwa of Mobye, while Captain Jackson made a detour with some cavalry and mounted infantry through the Southern States of the Myelat, *viâ* Loilon, Thigyit and Pinlaung. Thence it proceeded north-eastwards to Loipok in the Thaton State, crossing the Tabet river near Letmaing. From here the advance was continued due east across the Pon river to Maukmè, the capital of the State of that name. Still proceeding eastward, the column reached the Naimting or Tein river in two marches, and following the right bank of that river for a short distance, forded it at Tameungkè, whence Maingpan, still further east, was reached in two marches more. Here a halt of five days enabled Captain Jackson to make a reconnaissance to the Namkong (Salween) river, distant about 26 miles in a north-easterly direction. Returning from Maingpan to the Namting, the column turned northwards and passed through the States of Monè, Legya, and Maingkaing. From Monè, Lieutenant Stanton, the Intelligence Officer, made a reconnaissance in a north-easterly direction to the Salween, through the States of Kyaingtaung and Kyaingkam, and rejoined the column at Legya, returning in a north-westerly direction through the State of Maingnaung. The Salween was struck at two points, *viz.*, at Taseik and Takaw; at the former place the Nampan (Benchaung) river joins the Salween. From Maingkaing the route was continued in a north-easterly direction *viâ* Kyithi-bansan to Maing-yé and thence northward to Mansè on the Nammi river. From this place the column followed the routes to Thibaw, which had been lately traversed by the Northern Shan column (the account of which follows), *viz.*, *viâ* Lashio, Mansam and Panglon, and this portion of the expedition enabled Captain Jackson to test the accuracy of the surveys done by the sub-surveyor attached to that column. At Thibaw the

INDEX TO THE GEOGRAPHICAL SURVEYS IN UPPER BURMA.


NOTE.
Sheets on the Scale of 1 Inch = 8 Miles are numbered 1 2 &c.
A Sheet on the Scale of 1 Inch = 16 Miles will consist of four of the Sheets shown on the Index; they will be entitled thus, Sheet No. (1, 2, 4 and 5).
A Sheet on the Scale of 1 Inch = 4 Miles will consist of a one-fourth part of a Sheet shown on the Index, and will be entitled Sheet No. 1 N.E., 1 N.W., &c.
REFERENCES.
Reconnoitred previously
Do. during 1886-87
Do. do. 1887-88
MANDALAY
94°
96°
98°
100°
26°
24°
22°
20°
Miles

Reg. No 722 S. I. O.—1-3-89.—550.

Photo., S. I. O., Calcutta.

survey work was concluded, as the remaining part of the route to Mandalay lay through country which had been mapped during the previous field season. Captain Jackson kept up a rough continuous triangulation from the starting point of the expedition (Fort Stedman) to the Loilin range, about 20 miles north of Maing-yé, on reaching which, hazy weather, which always pervades the country from about the end of February, set in and rendered further triangulation impossible. Thus Captain Jackson was unable to connect his triangulation with that which had been brought up from Mandalay by Major Hobday during the previous season. A connection test was obtained, however, by the position of a high hill known as Loipan, about 25 miles south-west of Maing-yé, which had been mutually fixed, in the one case by triangulation and in the other by a plane-table fixing, with a coincident result, which is highly satisfactory considering the vast area over which Major Hobday's and Captain Jackson's reconnaissances had been extended, the total circuit thereof from Mandalay, *viâ* Kyaukse, Hlaingdet, Fort Stedman, Pekon, Maukmè, Monè, Maingkaing, Maing-yé, Thibaw, Thonzè, and Pyinulwin, being over 600 miles. Of the geographical results of this expedition, an area of 4,500 square miles of country has been more or less completely mapped. A portion of the routes traversed by this column had been followed by the party that accompanied the Salween expedition in 1864-65, and thus the surveys there executed by the late Mr. F. Fedden of the Geological Survey Department were tested and their general accuracy was fully established. By means of these surveys the route from Maing-yé south-eastwards to the Lukat ferry on the Salween can now be mapped with fair accuracy as well as the course of that river from Sukat to Takaw, the point reached by Lieutenant Stanton. An interesting account by Captain Jackson of his travels and operations with the Southern Shan column will be found in the appendix, page xxxvi.

Northern Shan column.

312. To continue with the surveys in the Shan States, Sub-Surveyor Faida Ali accompanied the Northern Shan expedition. Starting from Thibaw, the column marched northwards to Nansan, the chief town of the State of Taungbaing, which is situated on a high cluster of hills, like the Ruby Mine group and about the same altitude. Nansan is about 5,300 feet above sea-level and is renowned for its tea, for which there is a great demand. From here the column proceeded eastward across the Nantu or Myit-ngè river to Lashio and thence northward to Theinni-myoma, the capital of Theinni. From this place, during a halt of five days, reconnaissances were made in all directions, after which a move was made to Kunlon, a ferry on the Salween river, which is said to be 250 to 300 yards wide and very deep, when visited in February. From Kunlon the column retired to Maingyaw, five marches in a southwest direction, making *en route* a reconnaissance to another ferry on the Salween at Seupkyet. A noticeable feature in this part of the country is the proximity to the Salween of the main water-shed between that river and the Irrawaddy, the latter river being about 180 miles distant, whereas the Salween is only from 10 to 20 miles.

At Maingyaw the column was divided into two detachments, one making a tour round the disturbed districts of Maingma and Maing-kyeng to the south, whilst the other explored the country between Maingyaw and Lashio. By this means a large area of country was reconnoitred and mapped including the headwaters of the Nampan or Ben river, and the Salween was again visited near Pangmon and Mothè. The detachments re-assembled at Mansè, 15 miles south-east of Lashio, whence the column returned to Mandalay.

The area of country mapped independently by Sub-Surveyor Faida Ali during this expedition amounts to 3,425 square miles, which Major Hobday reports was done in an excellent manner, and that great credit is due to him. Major Hobday states that he is much indebted to Captain Yates, R.A., who was in command of the column, and to Lieutenant Daly, Political Officer, for the assistance they afforded the survey work on all occasions; also to Captain Yate, 1st Baluch Regiment, Intelligence Officer, for many useful reconnaissances.

Northern Yaw column.

313. To the west of the Irrawaddy a large area was reconnoitred in the Chindwin, Pakokku, and Minbu districts. From different points in these districts, four columns advanced into the Yaw country with a view of concentrating on Gangaw. The northern one started from Kalewa at the junction of the Myit-tha and Chindwin rivers and marched due south up the valley of the former river. As far as Kan, about 81 miles distant, Sub-Surveyor Bapu Jadu accompanied this column and

mapped in the course of the Myit-tha and its junction with the Manipur river. He was not, however, permitted to ascend the high hills on the west flank of the valley, for fear of collision with the Chins inhabiting them. From Kan the column returned by the same route as far as Kalemyo, when Bapu Jadu joined another column under Major McGregor, which was on its way to Manipur, and accompanied it as far as Auktaung in the Kubo valley, where he joined on to Colonel Woodthorpe's work of the previous year. At Auktaung he left the column and went across the hills, by what is known as the Minthami route, to Kindat on the Chindwin river; then going down the river by steamer to Alon, he reconnoitred the route from that place *viâ* Yeu and Shwebo to Kyaukmyaung on the Irrawaddy. After this the sub-surveyor was employed with a flying column in the Myinmu subdivision of the Sagaing district. The area surveyed by Bapu Jadu in the course of these operations amounts to about 2,600 square miles.

Central Yaw columns.

314. From Myaing in the Pakokku district, the second column, to which Mr. Kennedy was attached, started for the Yaw country. The advance was made *viâ* Kanlè and Leho to the valley of the Kyaw river, which was ascended nearly to its source at Saga; from here, however, the column was countermarched to Pouk, which is at the junction of the Kyaw and Yaw rivers. Subsequently it returned to Saga, whence Mr. Kennedy crossed the Paundaung range of hills on the west and descended into the Myit-tha valley, where the survey party was met by a detachment from the third or main column and escorted to Gangaw. After a few days' halt here, Mr. Kennedy returned with the third column *viâ* Telin to Pouk and proceeded thence to rejoin the second column at Leho. After this he was employed in surveying in the Pakokku district, in which, notwithstanding frequent attacks of illness, he mapped a large area of country. His out-turn during the season amounts to 2,606 square miles of topography.

Southern Yaw column.

315. The Southern or fourth column detailed for operations in the Yaw country started from Salen in the Minbu district, but was destined to proceed as far as Launghshè only, whence it returned by the same route that it went. Mr. Wyatt had been attached to this column and was kept in readiness to accompany it, but the start was so uncertain and had been so often postponed, that at length it was arranged that he should make his own way to Gangaw *viâ* Pakokku, Pouk and Telin, and return with the column from Launghshè. This was successfully carried out, and a large tract of unexplored country has thus been reconnoitred.

316. Previous to proceeding on the above expedition, Mr. Wyatt had been employed in extending the triangulation from Pagan down the Irrawaddy valley to Minbu, a distance of about 60 miles, and on his return from the Yaw country to Salen he surveyed parts of the Minbu district and extended the triangulation down the Irrawaddy to Thayetmyo, in the vicinity of which he effected a junction with the principal series of the Great Trigonometrical Survey, and at the same time completed the survey of the river to that place. The country mapped covers an area of 1,146 square miles.

Mogaung column.

317. In the northern portion of Upper Burma, a column, to which Mr. Kitchen and Sub-Surveyor Gobardhan Dass were attached, was detailed to operate in the country about Mogaung.

The column started from Bhamo and marched up the left bank of the Irrawaddy as far as Nanhe: crossing the river at this point, it proceeded along the right bank to Senbo, and from there, crossing the Mogaung river twice *en route* it passed through a flat, forest-clad country to Mogaung. Here a halt of several days was made when the opportunity was taken of measuring a base line for the purpose of furnishing fixed points for extending the survey.

The column continued its march through Kamein, where the Mogaung river was again crossed, to Sakaw and a halt was here made to allow of a temporary stockade being erected for the military police. From Sakaw the advance was continued in a north-westerly direction towards the jade mines. The Uru river was reached in four marches, and here the column again halted while negotiations were carried on with the local proprietors of the mines, which were about 7 miles distant. On the fifth day, a small party was able to visit the mines, returning to camp the same day. The column then retraced its steps to Sakaw, whence a portion proceeded by boats up the Endaw Chaung to the Endawgyi lake, returning by the same route. This lake is about 10 miles long and from 3 to

4 miles broad in the dry season. From Sakaw the column returned to Mogaung in two detachments, one by boat and the other by the land route to the north of the river, Mr. Kitchen accompanying the river party. Leaving some Goorkha police to garrison Mogaung, the force then returned *vid* Monhyin and Mawlu to Katha on the Irrawaddy. Throughout this expedition for political reasons the surveyors were not permitted to ascend the hills, for fear of inciting the Kachins, whose villages are invariably built on the hills and never in the plains or valleys. From this cause triangulation was rendered impossible and much additional topography was thus lost, for in many places there were cultivation clearings on the hills, from the summits of which extensive views might have been obtained.

318. Major Hobday reports that apparently there would be no difficulty in constructing a railway from Manlè (to the west of Katha) to Mogaung and Kamein, as the watershed between the Namyin Chaung, which flows north into the Mogaung river, and the Mawlu Chaung, which flows south into the Meza river, is a very low one. Beyond Kamein, the head waters of the Uru, Mogaung and Chindwin rivers have yet to be explored to fill the gap between Mr. Kitchen's survey and that done by Mr. Ogle in the expedition which went from Assam towards the Hukong valley, and which had satisfactorily settled the question of whether there is a practicable route from Assam over the Patkoi range into Upper Burma. After the return of the Mogaung column, Mr. Kitchen surveyed portions of the Katha district between Katha, Mawlu, Mawteik and Manlè and then returned to Bhamo, where he was incapacitated from further work by ill health. The sub-surveyor, however, completed the survey of the Irrawaddy from Bhamo to Tigyaing. The result of their operations amounts to 2,348 square miles of topography.

Miscellaneous Surveys.

319. At the commencement of the season, Mr. Powell was employed in surveying in the Wuntho district and mapped a portion of the country about Kawlin. He and Sub-Surveyor Ramsabad Misser were then attached to a small column under Colonel Symons, which proceeded from Tigyaing on the Irrawaddy to Kindat on the Chindwin river. A good survey of the route was obtained, but owing to the rapidity with which the column marched and the dense forest met with, it was found impossible to carry the triangulation more than half-way across. From Kindat Mr. Powell proceeded down the Chindwin river to Alon and completed the survey of the portion of that river from Alon to Pakokku. He then surveyed the Irrawaddy river from Pakokku to Myinmu.

On completing this, Mr. Powell was deputed to survey the approaches from Hlaingdet and Yamethin to the new military post which had been formed at Konni, on the Shan plateau, about 30 miles west of the Inlè lake. After arriving at Konni, and while marching northwards towards Pwehla, a most deplorable quarrel took place with the villagers at Senin, about 8 miles north of Thamakan. In the struggle which ensued, two Burmans were killed and one wounded, and Mr. Powell lost his life. A special local enquiry into the circumstances under which this unfortunate accident happened was made by the Local Government, and the result has been already reported to the Government of India. This young officer's untimely death is much regretted, for though he had been only a short time in the department, he had shown much ability and promise. The area surveyed by Mr. Powell and the sub-surveyor amounts to 1,513 square miles.

In the Minbu district the valleys of the Mon and Man rivers were surveyed by Sub-Surveyor Sher Shah, embracing an area of 1,254 square miles, which completes the record of the geographical surveys carried out by Major Hobday's party during the season under report.

320. The result of these operations is as follows:—

Triangulation has been carried over an area of 23,274 square miles, and the area of country mapped on the scale of 4 miles = 1 inch amounts to 20,780 square miles in the following States and districts:—

	Square miles.
In the Cis-Salween Shan States	9,814
„ the Yaw country „ Chindwin districts „ Pakokku district „ Minbu „	7,605
„ Bhamo „ „ Katha „	3,361

321. In addition to these reconnaissance surveys, a special survey was undertaken of the Ruby Mine tract on the urgent requisition of the Local Government. Mr. Penrose and 3 sub-surveyors were detached from the party in Lower Burma and placed under Major Hobday's superintendence for the purpose. The estimated area of 10 square miles over which these mines were supposed to extend proved to be very much under the mark, and the survey that was required to be made covers an area of 77 square miles, of which 21 square miles has been executed on a scale of 6 inches, and 56 square miles on the scale of 2 inches to the mile: useful maps have been prepared of this tract. The area of the entire ruby tract is now determined, and it can be readily reserved and demarcated.

322. Mr. Gibson has been employed throughout the year under the Local Government on special surveys in the town and suburbs of Mandalay. The survey of the town on the scale of 40 feet to an inch has been completed and the cadastral and sett lement surveys required were expected to be finished by the end of 1888. Mr. Gibson has now received a permanent appointment under the Local Government in the subordinate executive service of the Burma Commission and has left the Survey Department, in which he has done good service.

323. The very large amount of work which has been accomplished by this party in Upper Burma reflects considerable credit on Major Hobday and his assistants—on the former for the excellent management of his establishment, by which he was enabled to take advantage of every opportunity that permitted of adding to our knowledge of the country. He has been ably supported by Captain Jackson, R.E., who for the last two years has worked with indefatigable energy and success, and who fully deserves to be rewarded for his labours. The absence of his name from the military despatches is, it is presumed, due to an oversight, for no officer can have done harder or more useful work in Upper Burma.*

OPERATIONS WITH THE HUKONG VALLEY EXPEDITION.

324. In November 1887, the sanction of the Government of India was accorded to an expedition having for its object the exploration of the routes leading from Dibrugarh and Sibsagar in Upper Assam to the Hukong Valley in Upper Burma. The expedition was under the command of Mr. J. F. Needham, Assistant Political Officer at Sadiya, with a force of Frontier Police, and was accompanied by Captain Michell, Assistant Quarter Master General, and Mr. M. J. Ogle, Surveyor, with a small survey staff.

325. On the 25th November, Mr. Ogle, who was at Shillong, received instructions to make the preliminary arrangements, and by the 15th December having enlisted as many Khasi coolies as were obtainable and made all necessary arrangements for the survey work, the party started for Gauhatti, and thence proceeded to Dibrugarh on the 26th where Mr. Ogle joined Mr. Needham and Captain Michell.

326. The expedition started from Margherita, the terminus of the Assam Railway, on the 4th January, and returned thither on the 28th February 1888, having failed to reach its objective point owing to the impossibility of obtaining sufficient carriage, the lateness of the season and other reasons which it is unnecessary to refer to in this report. It was, however, successful in establishing the practicability of reaching the Hukong Valley by two distinct routes, *viz.*, firstly by the Nongyong Lake, Númyung and Daffa Nong's Village, which is two days' march from Mainkhwom, and, secondly, by the Naga Hills route which goes through the hills south of Margherita, *viâ* Yogli, Phung, Morang, Shánggé, Hashán, and Khulluk, to Sombia Nong's Village which is five marches from Mainkhwom. In addition to the information acquired as to these routes, about 1,500 square miles of entirely new country lying to the south of the Patkoi Range (up to which the country had been surveyed in 1873-74) was surveyed by Mr. Ogle and the new work connected with that done in 1884-85 to the east.

* Of his assistants Major Hobday reports:—"Captain Jackson has worked with his usual zeal and ability; he is an excellent workman and never spares himself.
"Lieutenant Renny-Tailyour has been most assiduous in his duties.
"The European assistants have all worked well under many trying and exceptional circumstances, notably Mr. Kennedy. Sub-surveyors Babu Jadu, Faida Ali and Ali Nawaz Khan have all done most creditably, while Sher Shah and the writer Girinda Nath Datta are deserving of mention."

327. The expedition advanced by the first of the two routes, which leaves the Dehing River at N. Dong, crosses the Patkoi at an elevation of 4,147 feet and goes by the Nongyong Lake and the Loglai river to Númyung, a small Singpho village of six houses situated on the left bank of the river of the same name. This village is 959 feet above sea-level and is eight marches distant from Daffa Nong's village in the Hukong Valley.

328. From this point the party turned westwards and entered the Naga Hills, commencing its journey to Hukong from the village of Phung. Passing through Morang and Shánggé, the Mu Bum Range was crossed at an elevation of 7,124 feet above sea-level. It then proceeded to the villages of Hashán and Khulluk, the latter being the furthest point reached. From this place, they retraced their steps to Phung and thence returned to Margherita *viâ* the Namchik river and Yogli, crossing over the Patkoi at an elevation of 7,192 feet. As regards the unexplored portion of the routes beyond Númyung and Khulluk, the furthest points reached, Mr. Ogle states that is no reason to apprehend that the difficulties therein were greater than those which had been overcome.

329. The country under survey contained three ranges of hills running parallel with one another, *viz.*, the Patkoi, the Mu Bum, and the Lungwak ranges. The two former throw out long spurs and have numerous villages upon them, situated at an average height of 4,000 feet above sea-level. The Dilli is the largest river flowing between them. Long spurs were likewise thrown out from the Mu Bum range to the south, but on these there are fewer villages. The Taga is the largest river between the Mu Bum and Lungwak ranges. To the east, the Loglai and the Númyung are the largest rivers, both flowing into the Turong which enters the Hukong Valley.

330. The Nagas who were met with to the south of the Patkoi are described by Mr. Ogle as human sacrificers, but of friendly disposition, though they refused to part with their rice at any price owing in all probability to their being insufficiently supplied themselves. Their friendliness was shown by their assistance in clearing ground for camping; bringing leaves to build huts; stowing away provisions in their villages when asked to do so (not an ounce of which was ever found missing); and in other friendly acts which the party had no right to expect from them.

331. Mr. Ogle is well-known on the Assam frontier as an able explorer and surveyor, and he has fully maintained his reputation for energy and success by the results of his labours in this expedition, which were obtained under considerable difficulties and much exposure. Extracts from his report will be found in the appendix.

OPERATIONS WITH THE HAZARA FIELD FORCE.

332. The military expedition to the Black Mountain in October and November 1888 afforded an opportunity for the extension of topography on the Hazara border. A party, consisting of Captain R. A. Wahab, R.E., and two sub-surveyors, Imam Sharif, K.B., and Ata Mahomed Khan, was detailed to accompany the force, and reached Abbottabad on the 25th September. Sub-Surveyor Imam Sharif was attached to the column about to advance by the Agror Valley, and Captain Wahab and Ata Mahomed proceeded to Darband to join the column operating along the Indus Valley.

333. The force crossed the frontier on the 3rd October, and survey work was carried on, as the troops advanced, by both parties. On the 9th October, Ata Mahomed died at Kotkai, and Captain Wahab was thus unable to leave the Indus Valley until he had completed as much of the topography as could be effected within reach of the posts occupied by the river column. Having done this, he left the Indus Valley and joined the head-quarters of the force at Chirmang on the 23rd October, in time to take part in the further operations against Thakot and Allahi.

Imam Sharif had in the meantime surveyed on the $\frac{1}{2}''$ scale as much of the western slopes of the Black Mountain as could be reached from the camps occupied by the columns operating on the crest of the mountain, and had also made a reconnaissance on the $2''$ scale of the routes followed by the troops on the eastern, or Agror, side of the range, which had been surveyed in sufficient detail on the smaller scale during the expedition of 1868.

Captain Wahab and Imam Sharif accompanied the reconnaissance to Thakot, which was reached on the 28th October, and the advance to Allahi on the 1st November. During the two days spent near the top of the Gorapher pass between Nandihar and Allahi, theodolite observations were taken from two stations which have been of great value in fixing a number of points in the ranges between the Swat and Indus Valleys.

334. This closed the field operations, and on the 9th November the force returned to Oghi where a halt was made until the 13th, pending the orders of Government regarding the march of the troops to the Chagarzai country. It is much to be regretted that this could not have been accomplished, as a considerable strip of the Indus Valley from Judbai to the mouth of the Chakesar Valley remains unvisited and therefore unsurveyed. Points were, however, approximately fixed on the hills immediately overlooking the river which determine its course within narrow limits. With the exception of this gap, about 13 miles in length, the course of the river Indus has been definitely fixed to some distance north of Thakot. Possibly when the frontier tribes have settled down again, arrangements may be made for the survey of that part of the valley under tribal escort, and the survey of the Indus Valley from our border to Thakot be thus completed.

335. The total area mapped on the $\frac{1}{2}''$ scale is 423 square miles. This includes a considerable area across the Indus adjoining Buner and of the Indus Valley above Thakot, which, though not traversed by the expedition, was sketched from commanding points.

The triangulation resulted in fixing 4 new stations and 18 points mostly situated in the hilly country between the Swat and Indus Rivers and extending over 600 square miles. The general run of the hill ranges and drainage lines in this area has also been sketched on the $\frac{1}{4}''$ scale. The heights of 24 points have been fixed trigonometrically, and in addition those of a number of points, such as passes and camping grounds, have been approximately fixed by the clinometer.

336. Before leaving Abbottabad a sketch map was compiled under the orders of the Major-General Commanding, on the 1″ scale, illustrating the military operations of the force. On the 22nd November the party returned to Dehra Dun and has since been employed in computing the results of the triangulation and in the preparation of the standard fair maps.

337. The General Officer Commanding the Field Force has brought the services of Captain Wahab and Sub-Surveyor Imam Sharif to the favourable notice of the Government of India in his despatch, dated 19th November last, in the following terms:—

"To the Survey party, working under the direction of Captain R. A. Wahab, R.E., much credit is due for the careful manner in which the map of the country through which the force has passed has been completed.

"Captain R. A. Wahab, R.E., has been unremitting in his endeavours, both with the river column and during the advance on Thakot and Allahi, to secure the greatest practicable extension of survey operations and geographical knowledge.

"Sub-Surveyor Imam Sharif, 'Khan Bahadur,' is deserving of special recognition for the manner in which he conducted survey operations along the crest of the Black Mountain independently."

TRANS-FRONTIER EXPLORATIONS.

338. The reconnaissance and approximate triangulation of Western Nepal has been extended eastwards from the Kumaun boundary to the Gandak river in Central Nepal. The work of this season combined with that of previous years now furnishes data for sketch maps along the whole southern frontier of Nepal. The materials are most scanty where the Gandak and Bágmati rivers break through the Himalayas into the plains, and most abundant in the neighbourhood of Kumaun on the west and Sikkim on the east, whence the observers could command a good view of the spurs of the Himalayas.

339. These operations were conducted by Sub-Surveyors Rinzin and Ramsaran who show special aptitude for the work. The results obtained are admittedly imperfect, not so much from inaccuracy of those which are given, as

from the immense amount of detail necessarily omitted owing to the method by which the geographical information can only be obtained. The greater part of the work has been done by distant sketching from the tower stations of the North-East Longitudinal series of the Great Trigonometrical Survey by means of previously fixed distant peaks, a method which enables the surveyor to fix with very fair accuracy the prominent points of ridges and any other features which he can see and identify, but leaves him very much in the dark as to the run of the valleys and intricacies of drainage. Vague and incomplete though they must be from their nature, still they are valuable contributions to our geographical knowledge of districts which without them have been an absolute "terra incognita" to us. The appendix contains some notes by Colonel Tanner, in which will be found some interesting information on the prosecution of this reconnaissance and on our present state of knowledge of the geography of Nepal, Sikkim, Assam and Bhutan, as well as suggestions as to the future field of work for sketch surveys of this nature.

340. A report is now being put through the press which embodies a large amount of information regarding Bhutan and Tibet collected by various explorers. It includes (1) those of K. P. and a Mongolian Lama on the Lower Sangpo referred to in paragraph 311 of the Annual Report for 1886-87; (2) a complete Narrative of Lama U. G.'s travels in Tibet; and (3) the itineraries of R. N. and P. A. referred to in the same Annual Report, page 8, paragraphs 21, 22. These will all be included in one report, and published separately from the Administration Report of the Survey of India Department, and will be illustrated by maps in which all existing information is embodied.

Summary of the Out-turn of Work of the

Scale of Survey.	Number of Party.	Locale of Field Operations.	TRIANGULATION.															
			Instrument used.	Area triangulated in square miles.	Number of stations at which observations were taken.	Number of square miles to each point trigonometrically fixed.	Number of square miles to each height.	Secondary—in which each angle is usually observed on two zeros.					Tertiary—in which two angles of each triangle are observed.					
								Number of stations fixed.	Number of triangles.	Triangular error in seconds.	Error per mile in feet.	Number of heights.	Number of intersected points fixed.	Number of triangles.	Error per mile in feet.	Number of heights.	Number of extra heights determined.	
50 feet=1 inch .	8	Town of Calcutta . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
24 inches=1 mile	5	City of Gorakhpur .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
16 inches=1 mile	2	Bilaspur . . .	...	...	...	...	...	...	..	...	...	...	...	...	...	...	...	
	...	Raipur . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	3	Nagpur and Wardha .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5
	4	Basti . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Chakia, Mirzapur .	...	...	...	...	...	..	...	...	...	...	...	...	...	...	...	
		Dudhi, do. . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	4A	Srinagar Estate .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	5	Gorakhpur . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	10
		Tarai . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Jhansi . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	6	Nowgong . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Sibsagar . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	7	Bassein . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	15
		Thongwa . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Sankarpur, Dinagepore	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Maldwar, do. .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	8	Angul, Orissa .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Bánki, Cuttack .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	20
		Kujang, do. . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Jubbulpore . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	9	Seoni . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	11	Seoni . . .	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Chhindwara . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	25
	12	Saugor . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Narsinghpur . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	13	Betul . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Hoshangabad . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	16	Quetta	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	30
8 inches=1 mile	5	Gorakhpur (Forests) .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	10	Kanara (do.) .	...	200	...	...	...	...	...	...	...	...	...	...	...	...	3,168	
	17	Nasik & Thana (do.) .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Deesa Cantonment .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
6 inches=1 mile	1	Gurdaspur . . .	...	...	...	...	...	...	...	..	...	...	...	...	...	...	...	35
	21	Upper Burma (Ruby Mines) . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
4 inches=1 mile	5	Gorakhpur . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Tarai . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	8	Angul, Orissa (Jungle Tracts) . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Angul, Orissa (Forests) .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	40
	14	Hoshangabad (do.) .	5", 6", & 7"	470	110	0·8	0·8	61	183	17	1·0	76	482	704	1·6	462	1,459(*f*)	
	18	Himalayas . .	5", 6", 7" & 12"	1,258(*i*)	155	1·7	1·7	119	196	14	0·47	119	596	522	0·95	502	145	
	19	Madura (Forests) .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	20	Lower Burma (Forests) .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
2 inches=1 mile	1	Punjab . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	45
	4	Mirzapur . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	7	Bassein and Thongwa .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	10	South Maratha Country	5", 6", & 7"	1,135	131	9·8	9·8	186	350	4·6	0·58	161	...	...	...	...	...	
	18	Himalayas . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	20	Lower Burma . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	50
	21	Upper Burma (Ruby Mines) . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
1 inch=1 mile .	19	Madras	8" & 12"	4,535	68	8·1	8·4	58	143	15	0·5	43	447	708	0·84	282	...	
½ inch=1 mile .	15	Baluchistan . . .	6"	7,300	27	270	270	27	43	8·9	0·33	12	162	271	0·5	68	(*j*)	
	16	Baluchistan . . .	8"	6,000	15	54·5	66·7	17	46	8·8	0·40	17	90	184	0·75	71	3	
	Detachment.	Black Mountain Country (*k*) . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	55
¼ inch=1 mile .	Detachment.	Hukong Valley . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Ditto	Upper Burma . .	...	23,274	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Ditto	Afghanistan . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	15	Baluchistan . . .	14"	...	19(*l*)	...	...	15	27	1·7	0·04	19	...	...	...	...	...	
	16	Baluchistan . . .	15¾"	4,725	11(*m*)	...	...	8	12	1·2	...	8	...	...	...	...	...	60
	24	Madras Coast . .	12"	2,100	38(*n*)	10	10	41	44	3·0	0·20	25	20	45	0·50	34	...	
	25	Madras and Bengal .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	

Field Parties during the year 1887-88.

SPIRIT LEVELLING OPERATIONS.						TRAVERSING.				TOPOGRAPHY.						Remarks.
Number of miles levelled over.	Number of permanent bench-mark stones embedded.	Number of Trigonometrical stations connected with lines of levels.	Number of permanent points fixed as bench-marks.	Number of stations at which theodolite was set up.	Linear miles.	Average angular error per station in seconds.	Average error per *mille*.	Square miles of village survey.	Area in square miles.	Average number of plane-table fixings per square mile.	Number of linear miles of test lines.	Number of villages.	Number of fields.	Average size of fields in acres.		
...	...	...	...	1,973	29	...	...	...	5	...	...	...	6,659(*a*)	0·19(*a*)		(*a*) Holdings.
...	...	...	...	...	...	...	...	...	5	...	...	68(*b*)	19,370	0·16		(*b*) *Mohallas*.
...	...	...	...	5,667	1,391	1	2	550	1,044	...	1,822	590	1,085,980	0·61		(*c*) Cultivated lands only have been surveyed.
...	...	...	...	13,122	2,868	1	3	996	...	...	...	547	...	...		
...	...	...	...	42,915	8,213	6	4	2,910	...	...	...	1,814	...	...		
...	...	...	...	...	...	...	...	...	491	...	1,426	902	9,87,579	0·32		(*d*) Calculated on cultivated portions only.
...	...	...	...	...	159	6	8	...	207	...	} 953 {	602	134,738	0·73		
...	...	...	...	...	...	...	...	...	42	...		186(*c*)	51,586	0·52		(*e*) Computations not yet completed.
...	...	...	...	17,389	3,357	6	2	706	355	...	653	234	346,248	0·39		
...	...	...	...	7,257	1,381	1	1	466	1,061	...	4,151	1,555	1,192,076	0·57		
...	...	...	...	4,573	890	2	2	121	158	...	804	115	50,581	2·0		(*f*) Determined by the clinometer.
...	...	...	...	14,245	3,05	2	...	880	...	...	...	348	...	...		
...	...	...	...	2,128	589	3	5	202	587	...	2,233	587	260,140	1·40		
...	...	...	...	6,211	3,097	3	5	386	...	...	...	...	...	...		(*g*) Inclusive of boundary survey of forest blocks.
...	...	...	...	...	...	...	...	17	62	...	} 733 {	33	40,459	} 0·50(*a*)		
...	...	...	...	10,757	2,678	1	1	922	729	...		281	215,622			
...	...	...	...	2,207	450	3	4	92	110	...	245	338	169,840	0·41		(*h*) Area tested only and maps compiled from village surveys by *patwáris*.
...	...	...	...	3,542	725	3	4	106	141	...	340	226	132,225	0·68		
...	...	...	...	7,547	1,319	4	10	337	330	...	442	385	191,462	1·10		
...	...	...	...	2,629	696	2	4	310	118	...	236	128	114,000	0·55		
...	...	...	...	6,405	1,169	...	...	200	...	...	...	388	...	...		(*i*) Includes area for 2″ survey.
...	...	...	...	36,962	6,086	2	3	1,996	...	...	...	1,002	...	...		
...	...	...	...	18,374	2,892	2	3	920	...	...	...	660	...	...		(*j*) Heights not yet computed.
...	...	...	...	20,025	2,685	6	7	1,071	...	...	...	483	...	...		
...	...	...	...	18,095	3,947	6	5	1,433	...	...	...	631	...	...		(*k*) Geographical survey.
...	...	...	...	22,720	4,228	7	1	1,471	...	...	...	897	...	...		
...	...	...	...	20,083	3,264	9	1	1,132	...	...	...	945	...	...		(*l*) Observations taken on 4 zeros.
...	...	...	...	18,425	} 8,319	1	3	{ 960	...	...	...	455	...	...		
...	...	...	...	18,628				{ 1,398	7	...	...	757	...	...		
...	...	...	...	256	26·1	3·95	·45	17·1	...	...	...	...	...	...		(*m*) Observations taken on 8 zeros.
...	...	...	...	...	...	...	...	...	141	...	...	14	...	...		(*n*) Observations taken on 4 zeros.
...	...	...	...	...	...	...	...	220	113	...	20	23	...	...		
...	...	...	...	324·8(*e*)	...	...	...	...	285	133	...	...	...	...		
...	...	...	...	...	...	...	...	...	64	...	...	...	...	...		
...	...	...	...	...	...	...	...	...	22	...	...	...	...	...		
...	...	...	...	...	...	...	...	...	21	...	...	...		...		
...	...	...	...	...	...	...	...	..	24	...	...	6	...	...		
...	...	...	...	...	...	...	...	...	66	...	...	23	...	...		
...	...	...	...	...	...	...	...	...	51	...	...	...	...	...		
...	...	...	...	...	...	...	...	...	36	...	...	...	...	...		
...	...	...	...	3,468	222·3	10	1·7	...	64	118	22	...	...	...		
...	...	...	...	2,657	628	17	0·5	...	416(*g*)	33	...	...	...	...		
...	...	...	...	1,399	...	33	3	40	8	87·1	...	...	...	...		
...	...	...	...	...	...	...	...	...	246	172	3·1	...	...	...		
...	...	...	...	20,024	8,384	3	0·45	5,795	2,473 (*h*)	...	...	...	...	...		
...	...	...	...	...	...	...	...	...	246	...	...	...	...	...		
...	...	...	...	...	...	...	...	...	44	...	...	...	...	...		
...	...	...	...	3,976	657	5	0·7	...	934	...	205	...	...	...		
...	...	...	...	...	...	...	...	...	361	18	...	...	...	...		
...	...	...	...	...	...	...	...	...	98	169	3·7	...	...	...		
...	...	...	...	...	...	...	...	...	56	...	...	...	...	...		
...	...	...	...	...	...	...	...	...	1,276	9·2	18	...	...	...		
...	...	...	...	...	...	...	...	...	7,564	1·2	...	...	...	...		
...	...	...	...	...	...	...	...	...	4,413	1·8	...	...	...	...		
...	...	...	...	...	...	...	...	...	423	...	...	...	...	...		
...	...	...	...	...	...	...	...	...	1,500	...	...	...	...	...		
...	...	...	...	...	...	...	...	...	20,780	...	...	...	...	...		
...	...	...	...	...	...	...	...	...	4,600	...	...	...	...	...		
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	}	Trigonometrical operations only.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...		
...	...	...	...	220	94	1	0·1	...	...	...	...	...	...	...		
597	60	10	531	...	...	...	...	...	...	...	...	...	...	...		

Statement showing the Cost-rates of work executed by the

Number of Party.	Nature and *locale* of Field Operations.	Cost-rate per square mile in Rupees.										
		Triangulation.	Traversing.	Detail Survey on Scales of								
				½"	1"	2"	4"	6"	8"	16"	24"	105·6"
	Topographical Surveys.											
4	Mirzapur	...	...	...	...	53·8	...	...	...	...	...	...
10	South Maratha Country	5·8	4·0	...	...	19·9	...	...	...	...	...	...
15	Baluchistan	2·7	...	6·7	...	...	...	...	...	...	...	...
16	Baluchistan	1·7	...	9·1	...	...	...	...	...	...	...	...
17	Gujarat	8·7	...	...	...	18·7	...	...		...	...	...
17	Deesa Cantonment	80·9		...	...	...	...	...	80·9	...	...	...
18	Himalayas	25·2	39·0(*d*)	...	...	...	94·9	...	...	...	...	...
		3·1	...	...	...	43·6	...					
19	Madras	9·7		...	17·7	...	...	...	...	...	...	...
21	Burma (Ruby Mines)	...	...	...	...	80·8(*g*)	...	22·1(*g*)	...	...	...	...
	Forest Surveys.											
5	Gorakhpur	...	26·7	...	...	...	...	...	13·6	...	...	...
8	Angul, Orissa	10·5	...	...	...	...	57·3	...	...	...	...	...
10	Kanara	6·6	78·8	...	...	...	...	...	130·7	...	...	...
14	Hoshangabad	29·5	39·1	...	...	...	251·3	...	...	...	...	...
17	Thana and Nasik	41·5		...	...	...	...	...	82	...	...	...
20	Burma (Lower)	...	...	...	...	15·6	266·1	...	...	...	...	...
	Cadastral Surveys.											
2	Bilaspur	...	14·8	...	...	...	...	...	...	51·1	...	...
4	Basti	...	...	...	...	...	...	...	...	96·8	...	...
4	Chakia, Mirzapur	...	...	...	...	...	...	...	...	70·8	...	...
4	Dudhi, do.	...	...	...	...	...	...	...	...	139·6	...	...
4*A*	Srinagar Estate, Bhagalpur and Monghyr.	...	21·8	...	...	...	...	...	...	72·8	...	...
5	Gorakhpur	...	26·7	...	...	...	34·7	...	...	60·3	390·1	...
5	Tarai	...	15·8	...	...	...	45·1	...	...	51·8	...	...
6	Nowgong and Sibsagar	...	31·7	...	...	...	...	...	...	71·7	...	...
7	Bassein and Thongwa	...	64·5	...	...	67·1	...	...	...	143·1	...	...
8	Sankarpur Estate, Dinagepore	...	49·7	...	...	...	...	...	...	82·4	...	...
8	Maldwar do., do.	...	48·7	...	...	...		...	...	79·5	...	...
8	Angul, Orissa	...	36·8	...	...	...	32·0	...	...	50·9	...	...
8	Bánki, Cuttack	...	24·2	..	...	...	...	...	...	66·6	...	...
8	Kujang, do.	...	15·5	.	...	...	...	...	...	...	...	...
	Traverse Surveys.											
1	Punjab	...	5·9(*s*)	...	6·7(*t*)	...	45·0	...	...	...	...	...
2	Raipur	...	14·8	...	...	...	...	...	...	...	...	...
3	Nagpur and Wardha	...	22·8	...	...	...	...	...	...	...	...	...
5	Jhansi	...	12·0	...	...	...	...	...	...	...	...	...
9	Jubbulpore and Seoni	...	21·0	...	...	...	...	...	...	..	...	...
11	Seoni and Chhindwara	...	25·6	...	...	...	...	...	...	...	...	...
12	Saugor and Narsinghpur	...	24·6	...	...	...	...	...	...	...	...	...
13	Hoshangabad and Betul	...	25·0	...	...	...	...	...	...	...	...	...
	City Survey.											
8	Calcutta	...	1,219·1	...	...	...	...	...	...	...	...	9,123·5

several Field Parties during the year 1887-88.

Rate in annas for traversing, detail survey, and preparation of maps.			Cost-rates.					Total cost.	Remarks.
Scale 16″ = 1 mile.			Stone embedding.	Records (*Khanapuri*).		Compilation of Vernacular Records, Assessment Statistics, &c.			
Per acre.		Per field.	Per square mile.	Per square mile.	Per field.	Per square mile.	Per field.		
a. *p.*		*a.* *p.*	₹	₹	*a.* *p.*	₹	*a.* *p.*	₹	
...		...	...	...	...	...	...	13,226	(*a*) Includes ₹16,045 expended on Trigonometrical operations; ₹1,486 on the fair mapping of the Kwaja Amran Survey, and ₹4,745 on the large scale survey of Quetta.
...		...	...	...	...	...	...	27,039	
...		...	...	...	...	...	...	92,888 (*a*)	
...		...	...	...	...	...	...	82,698 (*b*)	(*b*) Includes ₹16,184 expended on Trigonometrical operations; ₹6,014 on special operations; ₹3,978 on the large scale survey of Quetta, and ₹6,062 on triangulation in advance for 2″ survey.
...		...	...	...	...	...	...	46,369 (*c*)	(*c*) Includes ₹3,801 expended on boundary survey of Marwar-Meywar, Rajputana.
...		...	...	...	...	...	...	...	
...		...	...	...	...	...	...	82,427 (*e*)	(*d*) For purely settlement purposes.
...		...	...	...	...	...	...	68,690 (*f*)	(*e*) Includes ₹2,717 expended on triangulation and reconnaissance of western Nepal, and ₹2,688 in the instruction of four soldier-surveyors.
...		...	...	...	...	...	...	9,163	(*f*) Includes ₹1,915 expended on 4″ survey.
									(*g*) Includes cost of triangulation and traversing.
									(*h*) Includes ₹9,088 expended in bringing up the mapping and records of the Mirzapur Topographical Survey.
...		...	...	...	...	...	...	6,321	
...		...	...	...	...	...	...	6,040	(*i*) Includes ₹6,413 expended on 2″ mapping; ₹281 in instructing junior Civilians and ₹1,629 for leave pay of Deputy Superintendent.
...		...	...	...	...	...	...	33,431	
...		...	...	...	...	...	...	59,006	(*j*) Includes ₹2,371 expended on extra traversing.
...		...	...	...	...	...	...	36,870 (*h*)	
...		...	...	...	...	...	...	81,205	(*k*) Includes ₹1,059 expended on 2″ mapping and ₹637 in instructing junior Civilians.
									(*l*) Includes ₹2,985 expended on 4″ survey of Fuel and Fodder Reserves.
									(*m*) Includes ₹2,876 expended on 2″ mapping; ₹965 on revision work; ₹1,509 on training *mandals*, and ₹190 for paying their substitutes.
1 8		1 11	1·1	47·2	0 8	...	...	1,12,349	
2 5		0 9	...	35·2	0 3	59·7	0 6	1,02,474 (*i*)	(*n*) Includes ₹925 expended on revision survey. High cost-rate per field is due to paucity of fields in waste land tracts.
1 9		1 9	...	38·4	0 10	...	...	22,959 (*j*)	
3 6		1 10	...	...	...	...	...	5,856	(*o*) Includes ₹444 expended in Survey School.
2 4		1 11	9·4	50·5	0 10	...	...	65,693	
									(*p*) Includes ₹1,142 expended in Survey School.
2 2		1 2	4·2	25·7	0 4	30·1	0 5	1,42,151 (*k*)	
1 8		3 4	3·6	...	...		...	15,128 (*l*)	(*q*) Includes ₹1,933 expended in Survey School.
2 7		3 9	1·0	35·8	1 3	17·2	0 7	97,907 (*m*)	
5 2		10 9	...	...	...	...	...	1,76,481 (*n*)	(*r*) Includes ₹2,706 expended in Survey School.
3 4		1 4	2·3	37·0	0 7	29·1	0 6	26,723 (*o*)	
3 3		1 10	...	45·7	0 9	23·6	0 4	24,908 (*p*)	(*s*) Traversing limited to fixing village boundary tri-junction marks.
2 2		2 5	2·9	10·0	0 3	13·3	0 5	39,193 (*q*)	
2 3		1 6	7·0	20·2	0 4	21·2	0 3	21,402 (*r*)	(*t*) Topography not surveyed but obtained by reduction from settlement survey maps; the reduced maps are tested.
...		...	1·6	...	...	...	...	3,397	
									(*u*) Includes ₹8,842 expended in traversing and map compilation in Sikh States; ₹959 for mapping atlas reduction; ₹115 for Railway survey on 4″ scale through districts Sirsa and Hissar, and ₹146 for marking stations round Lahore City.
									(*v*) Includes ₹679 expended on drawing final maps.
...		...	...	...	...	...	...	63,914 (*u*)	
...		...	1·1	...	...	...	...	15,884	
...		...	2·6	...	...	...	...	73,838	
...		...	...	...	...	...	...	10,555	
...		...	2·0	...	...	...	...	67,393	
...		...	1·3	...	...	...	...	67,543	
...		...	1·4	...	...	...	...	67,515	
...		...	1·0	...	...	...	...	60,411	
		Per holding							
₹ *a.* *p.*		₹ *a.* *p.*							
16 2 7		7 7 10	...	...	...	...	...	50,566 (*v*)	

Tabulated Statement of the principal Records prepared in the several Recess Offices of the Field Parties of the Revenue Branch for the year 1887-88.

Number of Party.	Nature of Survey and Locality.	Mapping.						Traverses.		Field Books.		Area Books.		For Settlement Department.		Remarks.
		Original field Sections.	Cadastral 16-inch sheets.	Sheets, 4 inches = 1 mile $7\frac{1}{2}' \times 3\frac{3}{4}'$	Quarter sheets, 2 inches = 1 mile $15' \times 7\frac{1}{2}'$.	Index Maps.	Triangulation Charts.	Main circuit with azimuth computations. Vols.	Village or sub-circuit. Vols.	Main circuit. Vols.	Village or sub-circuit. Vols.	Villages.	Fields.	Sheets or tracings.	Village registers (khasras).	
	Cadastral Surveys.															
	North-Western Provinces.															
4	Mirzapur	1,367 on 16″ 3 on 4″ 14 on 2″	1,367	...	...	1	...	...	2	1	2	788	186,324	1,160	788	*Description of Records prepared by No. 4 Party for Civil Officers.* For Settlement Officer of Chakia and Naugarh—One trace map in Urdu; Urdu Khasra; Jumabandi slips and a dispute list of each village. For Collector, Mirzapur. Of Pargana Dudhi—One trace map of each village with one copy of area book for Collector's Office. One trace of each village on paper (complete) for Sazawal's Office; and one trace of detached blocks of cultivation in each village with Index on 2″ scale for *patwáris*.
	Basti	9 on 32″ 871 on 16″	9 on 32″ 871 on 16″	...	30	1	...	...	...	...	...	902	987,579	1,804	902	For Settlement Officer, Basti—For each village 2 trace maps (Urdu and Nagri), Urdu khasra with two dispute lists; Jumabandi slips; Book Jumabandi; *patwáris'* serial list; Terij; Caste statement; Agricultural statistics, and English village assessment statement with details of crops and caste.
4A	Srinagar Estate	474 on 16″	474	...	...	4	...	4	4	2	4	233	265,630	233	233	
5	Tarai	231 on 16″ 8 on 4″	231	8	...	1	...	2	3	2	4	115	50,581	115	115	
	Gorakhpur	42 on 24″ 1,802 on 16″ 43 on 8″ 4 on 4″	42 on 24″ 1,802 on 16″ 43 on 8″ 4 on 4″	...	7	1	...	1 1 Az.	2	1	4	1,637	1,214,872	3,274	1,637	
	Bengal.															
	(Districts Bhagalpur, Monghyr, Purneah, Maldah.)															
8	Dinagepore (Sankarpur Estate)	328 on 16″	...	...	...	1	...	...	...	...	...	340	130,250	340	340	
	Do. (Maldwar Estate)	261 on 16″	...	...	...	1	...	1	3	1	9	225	126,225	225	225	
	Cuttack (Angul Estate)	585 on 16″	...	...	...	1	...	...	...	...	...	385	191,462	385	385	
	Do. (Bánki)	11 on 64″ 20 on 32″ 167 on 16″	...	...	...	1	...	1	2	1	5	128	114,000	128	128	
	Assam.															
6	Nowgong	752 on 16″	...	...	4	1	...	1 1 Az.	1	1	1	587	260,140	663*	663*	* Includes tracings and statements referring to 30 Nisf-khiraj estates and 46 Waste Land Grants.
	Sibsagar	...	...	...	9	1	...	1 1 Az.	2	1	3	...	...	...	...	

	Central Provinces.															
1	Bilaspur	750 on 16″	750	...	...	1	...	1 1 Az.		1	3	621	1,140,895	1,242	591	
	Burma.															
7	Bassein	8 on 2″	82	...	...	...	...	...	...	...	...	...	...	...	...	
	Thongwa	1 on 2″	913	...	...	...	...	4	3	4	6	312	254,902	312	...	
	Akyab	...	...	...	36 on 2″ 1 on 1″	...	2	...	...	...	...	...	...	...	...	
	TRAVERSE SURVEYS.															
														Skeleton plots.		
2	Raipur	...	...	...	...	1	...	1 1 Az.	4	1	6	...	...	1,020	...	
3	Nagpur and Wardha	...	...	...	...	...	...	2	6	3	22	...	...	3,432	...	
9	Seoni	...	...	...	...	...	...	1 1 Az.	4	1	4	...	...	3,500	...	
	Jubbulpore	...	...	...	...	...	...	1	8	1	10	...	...			
11	Seoni	...	...	...	...	1	...	2	4	1	4	...	...	992	...	
	Chhindwara	...	...	...	...		...	2	8	1	8	...	...	2,319	...	
12	Narsinghpur	...	...	...	...	...	...	2 2 Az.	6	2	10	...	...	1,016	...	
	Saugor	...	...	...	...	...	...	2 2 Az.	7	2	12	...	...	1,383	...	
13	Hoshangabad	...	...	...	...	1	...	3	10	3	19	...	...	1,399	...	
	Betul	...	...	...	...		...	2	6	1	12	...	...	909	...	
	TOPOGRAPHICAL SURVEYS.															
	Punjab.															
1	Amritsar, Faridkot State, Ferozepore, Lahore, Ludhiana, Umballa, Sikh States, Kashmir.	75 on 2″	...	...	34 on 2″ 10 on 1″ 6 on ½″	1	...	3	3	3	11	...	...	6 Trav. Vols.	4 Index Charts.	
	Bombay.															
10	Belgaum and Dharwar	13 on 2″	...	...	10	2	3	...	3	...	2 (*a*)	...	...	...	...	(*a*) 1 Vol. contains 253 circuits of Khanapur Forest Survey.
	Kanara	33 on 8″	...	23 on 8″	...	1	...	...	1	...	1	...	...	...	...	
	CITY SURVEY.															
8	Calcutta	292 on 50′ =1 inch.	...	...	...	1	...	...	...	...	...	...	...	...	...	

Abstract of Out-turn and Cost of the Revenue Branch Parties according to Jurisdictions.

Province.	Scale of Survey.	Out-turn in square miles.	Cost.	Remarks.
			R	
North-Western Provinces	24 inches = 1 mile	5	3,18,670	(*a*) Topography tested only on maps compiled from the Settlement Survey Maps.
	16 „ = 1 „	1,959		
	8 „ = 1 „	141		
	4 „ = 1 „	90		
	2 „ = 1 „	246		
Bengal	50 feet = 1 inch	5	50,566	(*b*) Traverse Survey, of which village skeleton maps on 16″ scale are furnished on field surveys by *patwáris*.
	16 inches = 1 mile	1,054	1,83,958	
	4 „ = 1 „	87		
Punjab	6 „ = 1 „	22	63,914	
	2 „ = 1 „	2,473(*a*)		
Assam	16 „ = 1 „	587	97,907	
Bombay	8 „ = 1 „	113	60,470	
	2 „ = 1 „	934		
Central Provinces	16 „ = 1 „	1,044	4,64,933	
	16 „ = 1 „	14,287(*b*)		
Burma	16 „ = 1 „	791	1,76,481	
	2 „ = 1 „	44		
Total	.....	23,882	14,16,899	

PART III.

THE OPERATIONS AT THE HEAD-QUARTERS OFFICES.

341. These Offices comprise—

(1) The Head-Quarter Offices at Calcutta.

(2) The Trigonometrical Branch Office at Dehra Dun.

There has been hardly any change in the general administration of these offices. During the absence on privilege leave of Colonel D. Macdonald, S.C., Lieutenant-Colonel G. Strahan, R.E., was appointed to officiate as Assistant Surveyor-General, Surveyor-General's Office, from the 23rd July 1888. Major C. Strahan, R.E., on return from furlough, resumed charge of the Cartographic and Engraving Offices from Major A. W. Baird, R.E., on the 24th October 1887, and of the Map Record and Issue Office on the 4th November 1887. The work in each of the Head-Quarters Offices is described below:—

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1. HEAD-QUARTERS OFFICES, CALCUTTA.

SUPERINTENDENCE, CORRESPONDENCE, AND ACCOUNTS.

Personnel.

Colonel H. R. Thuillier, R.E., Surveyor-General of India.
Colonel J. Sconce, S.C., Deputy Surveyor-General, in charge Revenue Branch.
Colonel D. Macdonald, S.C., Deputy Superintendent, 1st grade, Assistant Surveyor-General.
Lieutenant-Colonel G. Strahan, R.E., Deputy Superintendent, 1st grade, Officiating Assistant Surveyor-General from 23rd July 1888.
Lieutenant G. B. Hodgson, S.C., Officiating Deputy Superintendent, 4th grade, Personal Assistant to the Surveyor-General.
Mr. T. W. Babonau, Registrar.

Correspondence.

Mr. M. Francis, Head Clerk.
„ E. D. Algar, do.
„ J. A. Vallis, Senior Examiner.
„ T. E. Ware, Clerk.
Babu Kally Podo Banerjee, Clerk.
„ Banee Madhub Banerjee, do.
„ Doorga Narain Ghose, do.
„ Ram Kristo Chunder, do.
„ Bheecum Singh, do.
„ Chuni Laul Dey, do.
„ Gopal Chunder Dass, do.
„ Raj Coomar Dutt, do.
and 14 others.

Accounts.

Mr. H. H. Fenwick, Head Accountant.
Babu Bama Churn Chuckerbutty, Accountant.
Mr. H. R. D'Mello, Accountant, on leave from 25th May 1888.
Babu Raj Krishna Mukerjee, Accountant,
and 5 others.

342. The Revenue Survey section of the office has been under the superintendence of Colonel J. Sconce, S.C., Deputy Surveyor-General, who has also carried on the duties in connection with accounts as well as the correspondence of this branch. The duties of the General and Topographical sections were supervised by Colonel D. Macdonald, and during his temporary absence on privilege leave by Lieutenant-Colonel G. Strahan, R.E. Lieutenant G. B. Hodgson, S.C., held the post of Personal Assistant to the Surveyor-General throughout the year.*

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* The Assistant Surveyor-General reports on the establishment as follows:—

"Mr. T. W. Babonau, Registrar, has supervised the office with his usual ability; Messrs. M. Francis, H. H. Fenwick and J. A. Vallis have all worked hard and steadily."

"The clerks generally have given satisfaction, and the following men deserve special mention: Banee Madhub Banerjee, Doorga Narain Ghose, Bama Churn Chuckerbutty, Bheecum Singh, Chuni Lall Dey, Raj Krishna Mukerjee, Hemnath Dutt, Khetter Mohun Dass, and Kanti Chunder Sen."

The Deputy Surveyor-General, Revenue Branch, reports very favourably of Mr. E. D. Algar, Babus Kaly Podo Banerjee, Ram Kristo Chunder, and Raj Coomar Dutt.

DRAWING OFFICE.

343. On his return from furlough on 24th October 1887, Major C. Strahan, R.E., Assistant Surveyor-General, resumed charge of this Office from Major A. W. Baird, R.E., and has held the post for the remainder of the Survey year under report. The Office is divided into three sections, which are reported on below, and a statement of the work executed in each section is given in the appendix.

Personnel.

Major A. W. Baird, R.E., Deputy Superintendent, 3rd grade, and Officiating Assistant Surveyor-General, in charge up to 23rd October 1887.
Major C. Strahan, R.E., Deputy Superintendent, 2nd grade, Assistant Surveyor-General from 24th October 1888.
Mr. G. A. McGill, Chief Draftsman.
„ P. J. W. Doran, Draftsman.
„ W. Green „
„ J. R. Adels „
„ A. J. Musgrove „
„ R. Sinclair „
„ A. S. Bateman „
„ G. Gill „
and two other draftsmen.

Additional Establishment.

Mr. W. Stotesbury, Surveyor, 4th grade, Draftsman, and 7 other draftsmen.

Native Draftsmen.

Munshi Sonaullah, retired 1st September 1888.
Munshi Nabi Buksh.
Babu Harihur Sen.
„ Mohesh Chunder Shaw.
Munshi Muttiullah.
Babu Purna Chunder Sen.
„ Gopal Chunder Roy,
and 36 others.

Surveyors and Assistant Surveyors on duty.

Mr. A. J. Wilson, Surveyor, 1st grade, from 26th March 1888.
Mr. S. M. Smylie, Surveyor, 1st grade,
„ E. S. P. Atkinson, Surveyor, 2nd grade, from 13th June 1888.
Mr. M. J. Ogle, Surveyor, 2nd grade, from 16th June 1888 to 20th July 1888.
Mr. F. Adams, Surveyor, 2nd grade.
„ S. O. Madras, Assistant Surveyor, 1st grade.
Mr. E. J. Martin, Assistant Surveyor, 1st grade, on leave from 13th April 1888.
and two sub-surveyors.

SECTION I.—GEOGRAPHICAL DRAWING AND COMPILATION.

344. The strain that has been thrown on this section in consequence of the urgent necessity of preparing general maps of Burma as well as of publishing the ¼-inch reconnaissance sheets thereof received from Major Hobday, together with the work connected with the N. W. Trans-Frontier mapping, has been so great that it has been found impossible to carry on all the departmental current work. The result has been that but little progress has been made in the drawing of the 8-mile maps of divisions, and that there has been a great decrease in the work given as copy to the engravers, so much so that there has been fear that there would shortly not be sufficient material to keep all the engravers employed: the bringing up of maps to date has also suffered. To remedy this pressure, it has now been arranged that all the N. W. Trans-Frontier mapping shall be undertaken at the Trigonometrical Branch Office, Dehra, except that connected with Baluchistan, and this will leave only the maps of Burma to be dealt with by this office and will enable due progress to be made with the ordinary current work.

345. The following entirely new compilations of Burma have been started and are making good progress:—(1) a 32-mile map with adjoining countries, which will include considerable portions of Assam, Eastern Bengal, and of the countries to the east of Burma; this map should be published in outline early in 1889; (2) a 16-mile map of Upper Burma, similar in limits to the previous preliminary edition, but an entirely new compilation; this will also be ready for printing in outline during January 1889; (3) the series of sheets on the 8-mile scale, in which good progress has also been made; but this is a work of some magnitude, and the completion of all the sheets will take a considerable time. Besides the above, new editions of the 4-mile sheets compiled in the field party office by Major Hobday have been completed and published.

346. The 24-mile map of Afghanistan in four sheets, of which the outline of one and the hill shading of all four was done in this office, has been completed, but required a thorough examination before publication: orders, however, have been received to delay the publication pending certain instructions from the Foreign Department. A 16-mile sheet showing Baluchistan was also completed in outline.

347. A new map of India on the scale of 48 miles = 1 inch, showing the divisions and districts with the principal towns and all railways open, under construction and proposed, has been drawn in outline for the Secretary of State; the hills will be added hereafter. This has also been reduced by photography to the

64-mile scale, and it is believed that the latter map will become popular and will be useful for purposes in which a very detailed map is not required.

348. The new edition of the 32-mile map of India has been nearly finished; it is hoped that it will be ready for publication in February or March 1889.

349. The examination of fair maps sent in by the field parties of the Topographical Branch, before passing them on for reproduction, has been carried on as usual.

SECTION II.—REVENUE.

350. Besides the regular work of examining and preparing for photozincography the fair maps received from the field parties of the Revenue Branch, of correcting to date and republishing old maps, of supplying data, &c., this section has been employed in drawing the fair topographical maps of the Gorakhpur and Mirzapur districts on the 2-inch scale, by reduction from the cadastral sheets on the 16-inch scale, and an 8-inch map of Benares city. The latter map is being prepared from the cadastral sheets on the 32-inch scale in the following way: a skeleton plot showing tri-junctions was made, and on to this the cadastral sheets were carefully mounted, each in its exact place, and made to form a 32-inch plan of the whole in four large sheets. These were reduced by photography to the 16-inch scale, transferred to zinc and prints of the map obtained in black on that scale. Tracing prints of the sheets were then prepared on which the draftsmen are drawing the new map for further reduction by photography to the 8-inch scale. By this method the immense labour of reducing by the pentagraph has been entirely avoided; the time thus saved is very great, and the risk of inaccuracy or error in drawing is reduced to a minimum. The tracing prints alluded to above are prepared in the following way: a sheet of bankpost paper is coated with gelatine and placed over a print of the map required to be drawn on; it is then passed through an ordinary lithographic press by which the bankpost is made to adhere so firmly to the map as to practically form a new surface to the paper, through which the printed detail is clearly visible, but it is of such a grey tint that it will not reproduce on the photographic plate. The draftsman then has merely to trace the details on the bankpost for the new map. These tracing prints serve all the purposes of blue prints; they are more easily prepared, and are better to draw on, as the bankpost paper is not greasy, which is often the case with the ordinary blue prints.

351. The preparation of $\frac{1}{2}$-inch district maps of the North-Western Provinces has also been undertaken in this office. Hitherto these and other maps, which are different from the publications of the Survey Department, have been prepared in the office of the Board of Revenue, in which a drawing establishment was maintained for the purpose. It was considered that such work could be more effectively done in the Survey Department under professional superintendence, and negotiations were therefore entered into for the transfer of the map-drawing work from the Board's Office to the Survey Department at Calcutta. It was eventually decided that the district maps remaining to be prepared, 12 in number, should be drawn in the Surveyor-General's Office, while the other publications required by the Local Administrations should continue to be issued by the Board's Office. By this plan it was estimated that the Board's map-making department would not be required to be retained beyond a period of two years.

352. For the preparation of these $\frac{1}{2}$-inch district maps a staff of nine draftsmen has been entertained at the expense of the Government of the North-Western Provinces, and the local drawing office has been correspondingly reduced. Tracing prints of the 1-inch standard sheets of the district are furnished to the draftsmen, and on these are drawn the necessary details for reduction to the $\frac{1}{2}$-inch scale. Of the twelve districts to be eventually prepared, four have been nearly completed so far as the drawing is concerned, whilst one has been printed and a proof sent to the Board of Revenue for approval. It is expected that four of these maps will be published by the end of March next.

353. The small computing section attached to this office has had an unusual amount of extra work thrown on it this year, so much so that the final examination of 10 per cent. of the computations and records received from the different parties has fallen into arrears. One very heavy task has been the connecting of the old triangulation of the Chittagong and Arakan Hill tracts with

the modern Great Trigonometrical Survey stations and the computing of the latitudes and longitudes of all the points. This was rendered necessary to enable a connection to be made with the triangulation of Upper Burma from the East, which will eventually be done by the reconnoitring parties employed thereon under Major Hobday.

SECTION III.—CADASTRAL.

354. The work of this section consists in preparing the original maps of the several cadastral surveys for publication, by examining the numbering of fields, to see that all holdings and divisions have been properly entered and referred to in the area statements; some of these sheets in which there is but little detail are traced in transfer ink and are printed by the zincographic method, whilst the others are photozincographed. The number of sheets thus passed for publication is 3,866, of which 929 were zincographed and 2,937 were photozincographed, showing an increase of about 100 sheets over the returns of last year. Of the printed copies 3,218 were coloured, and subsequently examined for lodgment with the settlement officers of the districts to which the maps appertained. The sheets, of which the publication has been finally completed, have been arranged and bound up into 87 volumes for record in this office, and 68 volumes of printed village maps of districts in Lower Burma have been also arranged by circles and townships, indexed, examined and bound up, and despatched to the Burma Government.

355. The demand for printed copies of cadastral maps by the public still continues, as is evidenced by the call for reprints of several hundred maps in districts Benares and Ghazipur owing to the stock of printed maps kept in the office of the Superintendent, Government Press, Allahabad, having been exhausted. The usual number of extra copies of village maps of districts Basti and Gorakhpur have been struck off for sale to the public from the depôts formed for that object in those districts.*

ENGRAVING OFFICE.

356. The supervision of this office has been in the hands of Mr. G. G. Palmer, who took over charge in September 1887. The progress made during this year, the first under Mr. Palmer, is highly satisfactory, more especially in the copper-plate printing section, where 21,300 pulls have been taken as against 11,700 during last year. This great increase is principally due to the number of heliogravure copies printed for the Archæological Survey Department. There is a slight decrease in hill etching, which is more than accounted for by the fact that Mr. Palmer's time was much occupied in attending to his duties as Head Engraver and to the untimely death in May 1888 of his son Mr. A. G. Palmer from the effects of an apparently trifling accident to his finger which brought on tetanus. Mr. A. G. Palmer was a talented artist and a good photographer, besides being a thoroughly efficient engraver, and his loss is a serious one to the office. Mr. Mitchell also was absent for nearly half the year on furlough, which he was forced to take on account of ill-health, whilst Mr. S. Coard was transferred to the Lithographic Office for three months during the absence of Mr. Lepage, the Head Assistant, for whom he acted. Considering the absence of these four experienced hands, the out-turn of hill etching is very satisfactory. Amongst

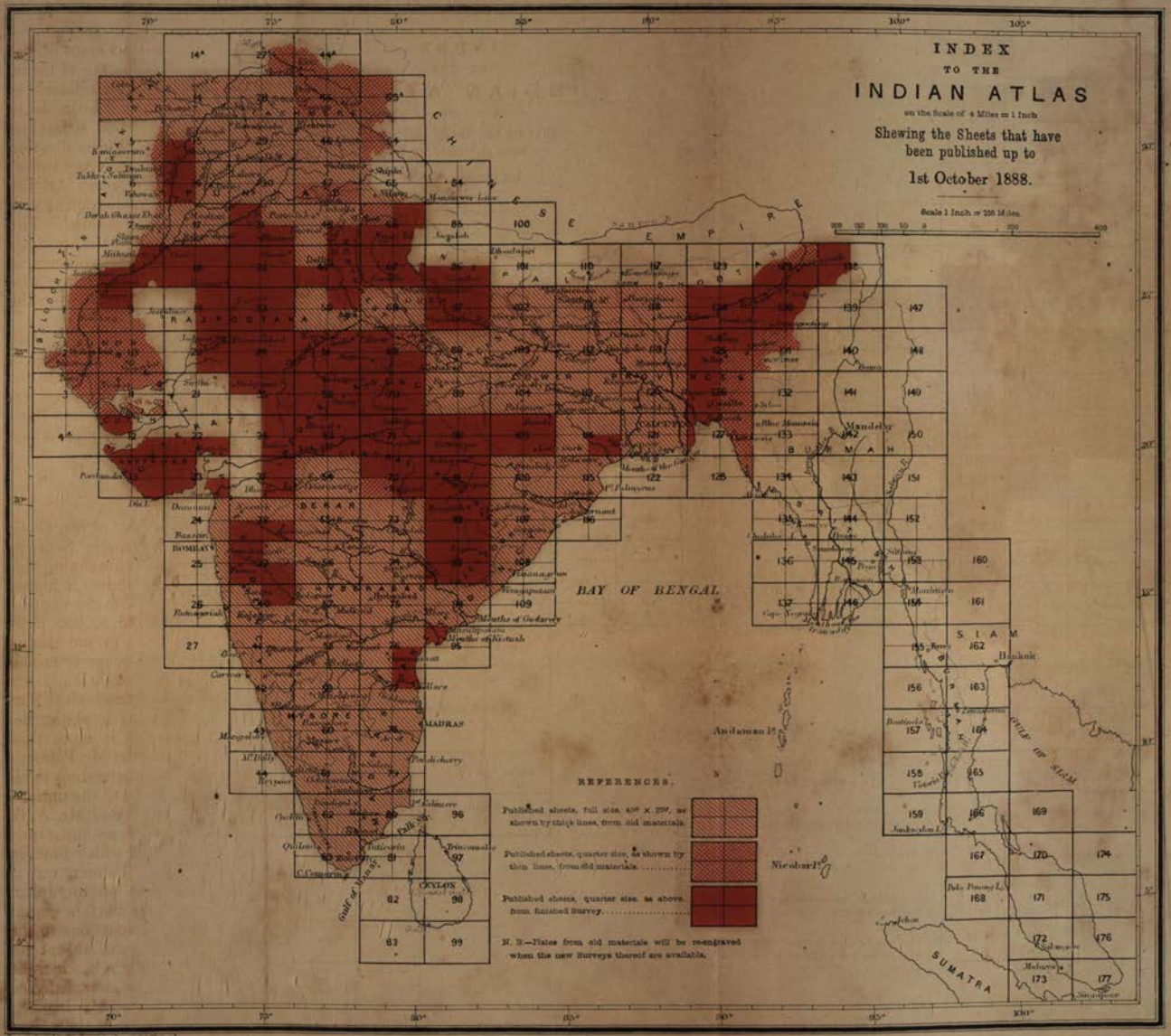
Personnel.

Major A. W. Baird, R.E., Deputy Superintendent, 3rd grade, and Officiating Assistant Surveyor-General, in charge up to 23rd October 1887.
Major C. Strahan, R.E., Deputy Superintendent, 2nd grade, and Assistant Surveyor-General from 24th October 1887.
Mr. G. G. Palmer, Superintendent, from 23rd September 1887.
Mr. W. Donaldson, Engraver.
„ D. L. Mitchell „ on furlough.
„ J. Fulford „
„ T. B. Roger „
„ A. G. Palmer „ died 5th May 1888.
Mr. S. M. Coard, Engraver.
„ A. W. N. James „
„ A. R. Coard „
„ E. C. Ollenbach „
„ E. Earle „
„ L. H. Musgrove „ from 1st January 1888.
Mr. T. R. C. Scallan, Engraver, from 1st July 1888.
22 Native Engravers.
3 Apprentices and 1 Storekeeper.

Copper-plate Printing Section.

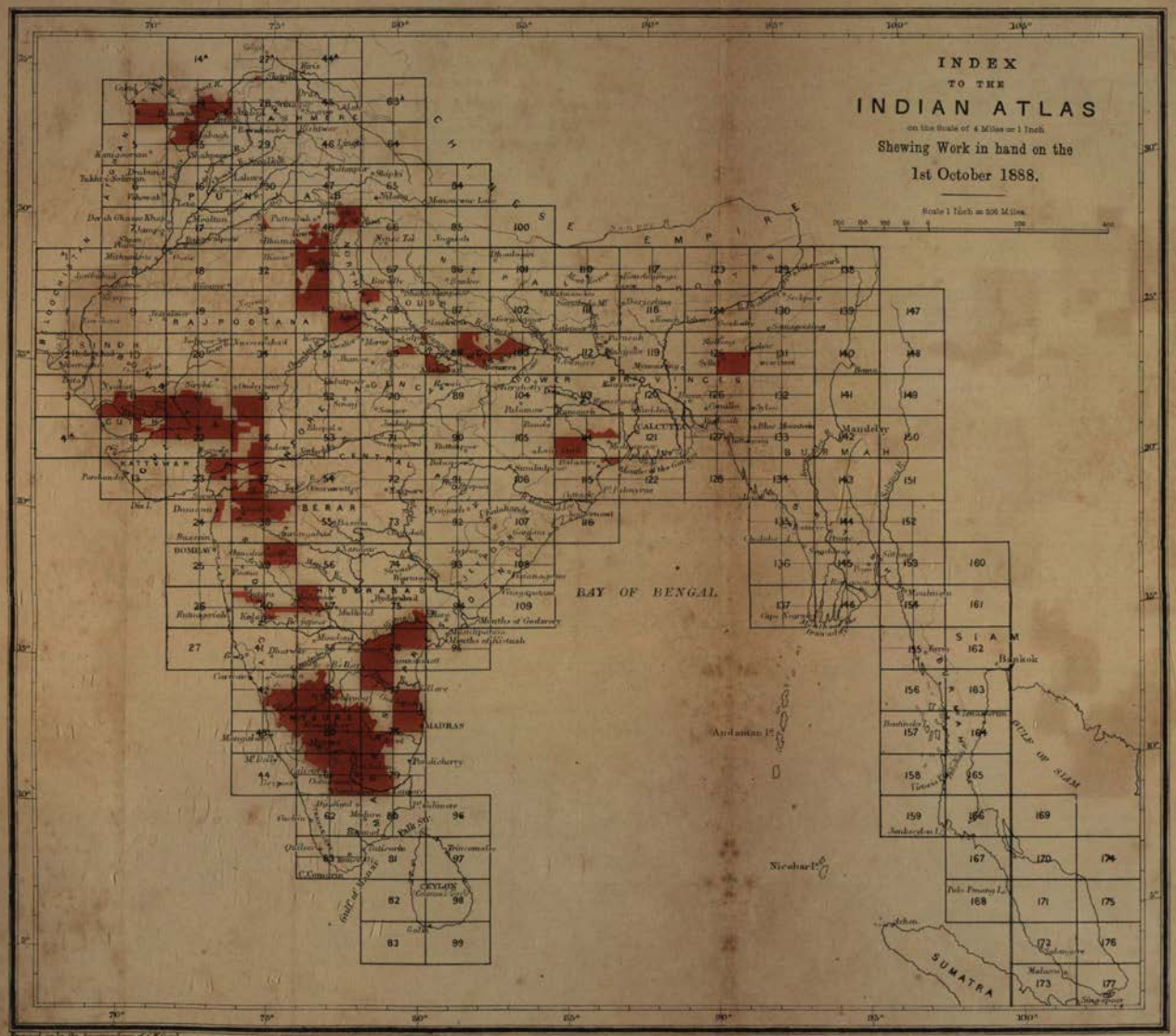
Mr. W. T. Collins, Copper-plate Printer.

* Major Strahan reports highly of Messrs. McGill, Smylie, and Stotesbury, who have supervised Sections I, II, and III respectively, and of Mr. Adams, whose special work is to see to the thorough examination of all the maps passing through the Geographical section. The other Surveyors and Assistant Surveyors as well as the European and native draftsmen have all, with only one or two exceptions, done good work.



Reg. No. 2256, S. I. O.—19-2-89.—450.

Litho., S. I. O., Calcutta.


INDEX
TO THE
INDIAN ATLAS
on the Scale of 4 Miles = 1 Inch
Shewing Work in hand on the
1st October 1888.
Scale 1 Inch = 256 Miles
BAY OF BENGAL
CHINESE EMPIRE
RAJPOOTANA
SINDH
KATTYWAR
BERAR
CENTRAL
OUDH
LOWER PROVINCES
CALCUTTA
BURMAH
Mandalay
SIAM
Bankok
GULF OF SIAM
SUMATRA
Andaman Is.
Nicobar Is.
MADRAS
CEYLON
BOMBAY
Mouths of Godavery
Mouths of Kistnah
Pondicherry
Trincomalee
C. Comorin
Gulf of Mannar
Palk Str.
Jankseelon I.
Pulo Penang I.
Achen
Malacca
Singapore
Lithographed by the Superintendent of C. W. Gould
Reg. No. 2436, G. I. O.—15-3-88—450.
Litho. S. I. O., Calcutta.

the outline engravers, Mr. Fulford was away for three months and some were employed in erasing the hills on the electrotype matrices of the 32-mile map of India. The time occupied in doing this has been calculated as equivalent to 875 square inches of outline engraving, and if it were added to the actual out-turn it would bring the total of outlining to the same as that of the previous year; the amount of lettering that has been done is considerably in excess.

357. The plates of the 32-mile map of India have been kept up to date as far as possible, and new transfers have been given therefrom to the Lithographic Office where a new edition of this map is being published. An outline map on the same scale has made good progress, and there is every reason to hope it will be published during 1889. This is being prepared by obtaining matrices from the original plates by the electrotype process, from which the hills are without difficulty erased. Duplicates are then taken by the same process, and these are re-engraved in those portions where the outline and names were unavoidably destroyed during the process of erasing the hills. The 16-mile map of the North-Western Provinces in 2 sheets is making good progress in outline, so far as reliable material exists, and a similar map of Mysore is in hand. One of the 4 sheets of the map of the Punjab is nearly completed in outline and lettering. The series of small maps of Bengal on the 80-mile scale for Administration Report purposes is very nearly complete, whilst those of the North-Western Provinces and Oudh are in hand. The details of the work performed will be found in the appendix at page LXII.*

PHOTOGRAPHIC OFFICE.

Personnel.

Lieutenant-Colonel J. Waterhouse, S.C., Assistant Surveyor-General, in charge.
Mr. T. A. Pope, Officiating Assistant Superintendent, 1st grade.

NEGATIVE SECTION.

Normal Establishment.

Mr. H. Haward, Head Assistant, in charge Negative Section.
Mr. G. G. Dempster, Officiating Photographer.
Ismail Khan, Assistant Photographer.
Mr. G. W. Mackie, Assistant Photographer.
Mr. E. Savedra, apprentice.
Two negative retouchers.

Cadastral Establishment.

Mr. C. Marshall, Photographer.
Mr. L. Lagnier, Photographer, on medical leave from 1st October to 14th December 1887.
Mr. T. Lloyd, Officiating Photographer.
Mr. C. DeCruze, Assistant Photographer.
Mr. C. Andrews, Officiating Assistant Photographer.
Three assistant photographers and 3 negative retouchers.

PHOTO-TRANSFER PRINTING SECTION.

Normal Establishment.

Mr. J. Harrold, Photographer.
Habbibul Hossain, Assistant Photographer.
Mr. P. C. Michael, apprentice.

Cadastral Establishment.

Mr. R. George, Photographer, and 2 assistant photographers.

SILVER PRINTING SECTION.

Normal Establishment.

Mr. C. J. Meade, Apprentice, and 1 assistant photographer.

HELIOGRAVURE AND COLLOTYPE SECTION.

Mr. A. W. Turner, Photo-Engraver.
Mr. L. H. Musgrove, Engraver, up to 1st January 1888.
Mr. P. Mackenzie, Apprentice, appointed 1st December 1887.
Three Copper-plate printers.
Four pressmen.
Mr. J. T. Meade, Collotype printer.

ZINC-PRINTING SECTION.

Normal Establishment.

Mr. B. Mackenzie, Zincographer, on furlough from 7th May 1888.
Mr. E. A. LeFranc, Zincographer, from 7th May 1888.
Mr. J. B. Mackenzie, Assistant Zincographer.
One writer.
Four zinc correctors.

Cadastral Establishment.

Mr. J. Watson, Zincographer.
Mr. G. A. LeFranc, Apprentice.
One writer.
Nine zinc correctors.

OFFICE ESTABLISHMENT.

Normal.

Mr. W. Moore, Store-keeper.
Babu Kanny Lall Sen, Clerk and Accountant.
Babu Gopal Chunder Mookerjee, Clerk.
One clerk.

Cadastral Establishment.

One clerk.

358. Lieutenant-Colonel J. Waterhouse has been in charge of the Photographic Office throughout the year. Mr. B. Mackenzie, Zincographer, in charge of the Normal Printing Establishment, obtained furlough for two years in May, his place being filled by Mr. LeFranc. With the sanction of the Government, arrangements have been made for Mr. Mackenzie to visit the Ordnance Survey Office, Southampton, while on furlough, with a view to his learning the working of the steam printing machine which it is intended to introduce into the office during the coming year. He will also visit one or two other large establishments in order to acquire a knowledge of the latest improvements in zincographic printing.

* The European engravers have all done good work, and the apprentices have made sufficient progress to allow of their working on plates of the Atlas of India. The native engravers are also on the whole well reported on.

359. The out-turn and value of work for the past year are shown in the abstract given further on. The number of original subjects received for reproduction was 5,340, or 537 more than last year. The increase is principally in work sent in by other departments, of which the number of original subjects received was 842, or 376 more than last year. The total number of departmental maps and plans received for reproduction was 4,498 (cadastral 3,870, normal 628), against 4,337 for last year (cadastral 3,618, normal 719). The number of negatives taken was 4,902, being an increase of 557 over the previous year. In the Zinc-printing Section, the amount of ordinary departmental work done was considerably less than usual, the total number of plates printed being 324 against 495 in the preceding year, and of pulls 51,665 against 72,920. The decrease is chiefly owing to the small number of standard sheets received for reproduction—only 270, or 122 less than last year, which is due to the contraction of topographical surveys. Of extra-departmental maps and plans there were 323 plates printed, from which 64,127 pulls were taken; a satisfactory increase upon last year during which 279 plates were printed and 56,636 pulls taken. In cadastral maps there is also a slight increase, 3,897 plates having been printed with 121,921 pulls, the figures for the preceding year being 3,744 plates and 116,081 pulls. The out-turn of this class of work is still small as compared with that of former years owing to the smaller number of field parties employed on that class of survey.

360. In the Silver Printing Section the amount of work done is satisfactory. The number of silver prints made was 1,771 and of cyanotype prints 672, or 2,443 prints in all, against a total of 1,436 last year.

361. In the Collotype Section the number of plates prepared is the same as last year, *viz.*, 30, but the number of copies printed from them is smaller, *viz.*, 4,929 against 6,608 last year. None of these plates were printed for experimental purposes, but most of them were for illustrations for the Journal of the Asiatic Society, and they included reproductions of photographs taken in the office of a bronze figure of Hercules found in the Quetta Miri and of several ancient copper-plate inscriptions. It is probable that in time the collotype process will be virtually abandoned in favour of the photo-etching process. In the latter, a reversed negative is not required, as is usually the case in collotype; the etched plates can be prepared with far greater ease and rapidity while they also yield a much larger number of copies, all of equal quality, and as a rule they are more artistic than the collotype prints.

362. In the Heliogravure Section, the number of plates photo-electrotyped is one more than last year, *viz.*, 23, and of plates photo-etched 59, or 36 more than last year. The former process was chiefly utilized in reproducing the archæological drawings for distribution among the Art schools of India, of which a series was commenced last year. Two sheets of the reduced map of the Andaman Islands on the scale of $1'' = 4$ miles were reproduced in this way, also two large architectural subjects for Lieutenant-Colonel S. S. Jacob, R.E., for the Jeypore portfolio of architecture. The photo-etching process has been very successfully worked throughout the year, and it is believed it will ultimately supersede the slower and more expensive method of photo-electro-typing, both for half-tone and line subjects. During the year much experience has been gained in working the process, though it has not been found necessary to make any important modification in the methods employed as described in previous Annual Reports. Some of the plates lately prepared have been so perfect as to require little or no touching up by hand. A large number of plates have been prepared for Dr. Burgess, Director-General of the Archæological Survey, to illustrate his report on the antiquities of Jaunpur, among them nine half-tone subjects photographed from nature. Fifteen small plates were also prepared from negatives taken during the Gilgit Mission.

The frontispiece of this report representing the new Head-Quarters Offices, Survey of India, at Calcutta, and the plate of the new Mathematical Instrument Office which faces page 92, are good specimens of the work now produced by this process. A complete account of the process as now worked is given in the appendix, and considerable credit is due to Mr. A. W. Turner for the successful working thereof.

363. Besides the photo-electrotype work mentioned above, the electro-typing batteries were employed in duplicating the hand-engraved copper-plates of five

sheets of the 32-mile map of India, also that of the Provincial map of the North-Western Provinces and Oudh, and of three quarter-sheets of the Atlas of India. In all 13 matrices and duplicates have been prepared during the year.

364. Some experiments were made in the course of the year by Mr. A. W. Turner in direct zinc-printing by the asphalt process, of which full details are given in the appendix. With a little more practice in working it this process will prove very useful for printing maps in two or more colours, as it dispenses entirely with the necessity for transfer printing. The image is impressed directly through a reversed negative upon the surface of the zinc plate which is covered with a coating of sensitive asphalt; all possibility of stretching or distortion is avoided, and a more perfect register may be obtained than is possible by the photo-transfer method, especially when the transfer prints have to be joined up in several sections.

General Abstract of Work done during 1887-88.

Description of Work.	Negatives.		Photo-zincographic Printing.					Silver and other Printing.		Heliogravure and Electro-typing.					Photo-collotype.		Value.
	Sheets or subjects.	Direct negatives.	Reversed negatives and transparencies.	Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Pulls.	Copies.	Silver prints.	Blue prints.	Plates photo-electro-typed.	Plates photo-etched.	Prints.	Photo-blocks.	Electro-types.	Plates.	Prints.	
																		R a. p.
Departmental maps and plans.	628	1,010	19	855	260	324	51,665	50,871	215	492	4	23	920	...	13	9	606	26,385 10 9
Cadastral maps . .	3,870	2,971	...	2,953	3,897	3,897	1,21,921	1,14,733	...	...	...	...	...	...	...	...	...	61,370 2 9
Extra-departmental maps and plans.	842	921	51	798	306	323	64,127	91,122	1,556	180	19	36	9,842	...	...	21	4,323	31,035 14 3
Total .	5,340	4,902	70	4,606	4,463	4,544	2,37,713	2,56,726	1,771	672	23	59	10,762	...	13	30	4,929	1,18,791 11 9

365. The departmental publications for the year are detailed in the statement given in the appendix. They include, under the head of General Maps, a new map of India, including Upper Burma, published for the Secretary of State on the scales of 1″=48 miles, 64 miles and 96 miles respectively. Under the head of City and Cantonment Maps, four sheets of a map of Mandalay city and a plan of the ruins of Pagan (scale 6″ = 1 mile) were printed off.

366. Of standard sheets, 167 were printed off, including two sheets of Northern Afghanistan, two of the Andaman Survey, 35 of the Bombay Survey, 16 of the Burma Survey, seven of Central India and Rajputana, five of the Hooghly River Survey, ten of the North-Western Provinces, two of the North-East Trans-frontier, nine of the South-East Trans-frontier, and 29 of the Punjab. Of Index maps 54 were printed off on various scales.

367. The particulars of work done for other departments are given in the usual statement in the appendix. For the Government of India, Public Works Department, a map of India showing Feeders to Railways, scale 1″=32 miles, in 6 sheets, was reproduced; also a large number of plans of the Betwa Canal, the Kidderpore Docks, the Khusdil Khan Reservoir, and of Secretariat buildings at Simla. About 16,000 copies of diagrams showing the rise and fall of rivers and canals were printed for the Public Works Department of the North-Western Provinces and Oudh. Thirty district maps have been reproduced on various scales for the Revenue departments of the Bengal, Punjab and North-Western Provinces Governments. A very large number of copies of standard plans and type drawings were photo-zincographed for the Inspector-General of Military Works; and for the Quarter-Master-Generals in India and Madras a variety of military maps for the Black Mountain Expedition, Camps of Exercise, &c., have been prepared. For the Port Commissioners, the complete chart showing the survey of the River Hooghly from Calcutta to Saugor, in three sheets, was printed, as well as three sheets of the Hooghly River Survey. For the Sanitary Commissioner, Bengal, a cholera map of Bengal was printed off.

The reproduction of the series of archæological drawings ordered by the Revenue and Agricultural Department for distribution to the various Art schools in India was continued throughout the year. In all 14 plates have been prepared and printed off, and 6 more are in hand. Considerable progress has also been made with the illustrations for the Archæological Survey Reports for Dr. Burgess, of which 13 plates were printed off by different processes.

368. The expenditure of the office during the year has been R1,20,467-1-7, and the value of the work done R1,23,282-15-8, showing a nominal balance of R2,815-14-1 in favour of the office, which is satisfactory.

369. A large number of experiments were made during the year in the preparation of direct positives in the camera. These are required for the production of maps in two or more colours, which it is desired to print direct upon zinc plates by the asphalt process previously mentioned. Several methods of obtaining such direct positives were tried, of which full details are given in Colonel Waterhouse's narrative report in the appendix. The most suitable seems to be a method employed in the Service Géographique de l'Armée, Paris, by which very fair results were obtained in this office, though it has the disadvantage of involving the use of a bath of a very corrosive nature consisting of a mixture of strong nitric acid and bichromate of potash. Experiments were also made by Mr. Pope with the positive cyanotype printing processes, known in France by the names of the Cyanofer or Gummo-ferrique processes, by which positive copies in blue on a white ground can be obtained from plans or drawings traced on ordinary tracing paper or cloth. These processes are the reverse of the ordinary cyanotype process in which a negative is employed. A memorandum on the subject, of which an extract is given in the appendix, was drawn up for the information of the Government of Bengal, Public Works Department.

370. Early in February 1888, the erection of the new buildings sanctioned by Government for the Photographic and Lithographic Offices was commenced. The work has proceeded rapidly throughout the year, and it is hoped that they will be ready for occupation in July 1889. The re-arrangement of the buildings, described in the appendix to last year's report, is being adhered to, and new plans, together with a complete descriptive list of the fittings required, were prepared during the year by Colonel Waterhouse. Sanction having been obtained for the introduction of steam machinery into the office, a special indent has been submitted for the machinery required which will, it is hoped, arrive before the completion of the new building.

371. As the stock of old negatives kept in the office has been steadily increasing for many years, it was thought desirable to go through them in order that those not likely to be required might be cleaned off. This was done at the close of the year, some 3,000 negatives having been examined and the greater part set aside for cleaning. The remainder were re-arranged in the most convenient manner practicable.

Full details regarding changes in the processes used and in experimental work are given in the appendix.*

* Colonel Waterhouse again reports very favourably of his European and native assistants and apprentices, who have continued to perform their duties satisfactorily.

LITHOGRAPHIC OFFICE.

372. Lieutenant-Colonel J. Waterhouse continued in charge of the office during the year under review. During the absence on privilege leave of the Head Assistant, Mr. H. L. Lepage, from the 9th July to the 8th October 1888, Mr. S. M. Coard of the Engraving Office officiated in his place, and Colonel Waterhouse reports that he supervised the work of the office in a highly satisfactory manner.

Personnel.

Lieutenant-Colonel J. Waterhouse, S.C., mssistant Surveyor-General in charge.
Mr. T. A. Pope, Assistant Superintendent.
„ H. L. Lepage, Head Assistant (on privilege leave from 9th July to 8th October 1888).
Mr. S. M. Coard, Officiating Head Assistant (from 9th July to 8th October 1888).
Baboo Ambika Churn Mookerjee, Examiner.
Moonshi Sobhan Buksh and 24 others . . . } Draftsmen.
Mr. D. Deas, Head Lithographic Printer.
„ B. Wilson, Assistant ditto. Resigned on 1st December 1887.
Mr. S. U. Ravenscroft, Assistant Lithographic Printer. Appointed from 1st December 1887, and 74 others.
Mr. E. DePyvah, Head Type Printer, and 25 others.
6 clerks and 12 others.
Mr. G. A. Lefranc (employed in Photographic Office from March 1888). } Apprentices.
Mr. E. Dowling . . . }

373. The out-turn of work during the year as shown in the abstract given below is considerably more than last year, and is greater than in any previous year with the exception of 1885-86.

The number of subjects taken up in the Drawing and Lithographic Sections and for the most part printed off amounts to 716, of which 177 were departmental and 539 extra-departmental, in all 69 more than last year. The total number of pulls was 392,554, or 129,418 more than last year: the number of complete copies was 410,391, or 165,614 more than last year. The extra-departmental work shows a considerable increase, the number of pulls being 259,322, or 115,461 more than last year, and the number of copies 279,837 or 137,881 over last year.

In the Type Printing Section the work performed was also considerably in excess of last year. The total number of pulls was 986,666, and complete copies 497,289, against 841,121 pulls and 424,886 copies of last year.

General Abstract of work done during the year 1887-88.

Description of Work.	Lithographic Printing.				Type Printing.		Total pulls.	Total copies.	Value.	Remarks.
	Sheets or subjects.	Stones.	Coloured copies.	Uncoloured copies.	Pages or items.	Pulls.				
									R a. p.	
Departmental.										
General Maps . . .	21	33	600	300	...	...	4,450	900	1,009 4 0	
	3	3	...	...	...	...	..	...	748 15 0	Not yet printed.
Provincial Maps . . .	6	10	...	400	...	...	1,100	400	156 14 0	
	2	2	...	...	...	...	...	...	248 11 0	Ditto.
Divisional Maps . . .	1	1	...	25	...	...	25	25	19 11 0	
District Maps . . .	7	7	...	850	...	...	850	850	588 3 0	
	6	6	...	...	...	...	...	...	1,597 11 0	Ditto.
City and Cantonment Plans .	2	2	...	150	...	...	150	150	44 5 0	
Atlas Sheet	1	1	...	...	...	...	...	...	228 4 0	Ditto.
Standard sheets . . .	3	3	...	600	...	...	600	600	1,269 7 0	
	12	12	...	...	...	...	...	...	6,221 12 0	Ditto.
Index Maps . . .	3	5	1,000	610	...	...	2,610	1,610	210 6 0	
Miscellaneous Maps, Plans, &c.	52	42	2,255	15,519	...	...	12,827	17,774	849 15 0	
	1	1	...	...	...	...	...	...	225 0 0	Ditto.
Departmental Forms . .	57	53	...	108,245	...	...	110,620	108,245	9,305 11 0	
Total .	177	181	3,855	126,699	...	...	133,232	130,554	22,724 1 0	
Work done for other Departments.	539	387	24,862	254,975	...	...	259,322	279,837	27,296 5 6	
Total of Drawing and Printing.	716	568	28,717	381,674	...	...	4392,55	410,391	50,020 6 6	
Work done in Type Printing Section.	...	...	...	...	5,375	986 666	...	497,289	15,783 9 0	
Total Value .	...	...	...	...	...	...	...	...	65,803 15 6	

374. The departmental work that has been done is very much less than the extra-departmental, and is now almost e ntirely confined to the reproduction of the old surveys of the North-West Provinces and Bengal, and to the preparation of district maps on the scale of 1″=4 miles, and general maps of India by transfer from the engraved copper-plates. Twelve standard sheets of the Oudh Revenue Survey on the scale of 1″=1 mile, districts Kheri, Bahraich, Bara Banki, Gonda, and Fyzabad, were drawn during the year, and

three sheets, districts Hardoi, Sitapur, and Kheri, were printed off. Seven district maps, *viz.*:—24-Pergunnahs, Gya, Hazaribagh, Durbhunga, Mozufferpore, Sarun and Chanda, were transferred to stone from the sheets of the Atlas of India, and additions, &c., made, and districts Jubbulpore, Burdwan, Nowgong, Moorshedabad, and 24-Pergunnahs have been printed off. The new edition of the 32-mile map of India has progressed but slowly during the year. Two more sheets, Nos. 3 and 5, have been transferred, and alterations and additions have been made to them. Sheet 2 has had further correction, and sheet 1 remained to be transferred, but it is hoped that this new edition, which is so much needed, will be ready early next year. The delay has chiefly arisen from the necessity of recompiling the Burma portion of sheet 4. Considerable changes have also been made in sheets 2 and 3 and new materials incorporated.

375. Of the extra-departmental work, the most important item is the Military and Railway map in 12 sheets on the scale of 1″=32 miles, which has made good progress during the year. All the sheets have now been drawn with the exception of sheet 7, the hills of which have to be corrected from new material received, and this has somewhat delayed its completion. Sheets 3 and 4 have had to be redrawn from newer material, and this also has caused delay. Of the twelve sheets, Nos. 9, 10, 11 and 12 have been sent to the Quarter-Master-General for press order, and Nos. 2, 3, 4, 5 and 6 are nearly ready for final press order; Nos. 1 and 8 are under correction and examination, and sheet 7 is in hand. It is hoped that the whole map will be completed early next year. Of the series of military maps of Country 10 miles round Cantonments, prepared for the Quarter-Master-General's Department, two, Amritsur and Jhansi, have been printed off, and two, Belgaum and Jhelum, were drawn.

Maps of the Central Himalayas, in one colour, and of South India, in three colours, were prepared and printed off, and a map of district Jubbulpore was drawn but not printed for the Geological Survey Department. For the Meteorological Departments of India and Bengal, a large number of diagrams and plates have been prepared, and the small hand lithographic machine has been kept almost constantly employed in turning out the daily weather charts, of which 93,300 have been printed for India and 25,400 for Bengal. Six plates have been drawn in chalk and printed for the Scientific Memoirs by Medical officers of the Army in India. Three more of the series of Crop maps of India, on the scale of 1″=64 miles, *viz.*, Sugarcane, Wheat and Indigo, were printed.

A very large number of maps of Bengal on the scale of 1″=80 miles have been prepared and printed in colours for the provincial administration report, to illustrate education, revenue, registration, emigration, crime, excise, diseases, &c., &c. Similar maps of the Punjab illustrating registration, income and license taxes were printed for the Punjab Government. For the Director-General of Railways, two Railway maps have been prepared on the scale of 1″=96 miles, showing gauges and systems. A large number of plates illustrating Dr. Burgess' report on the archæological remains at Jaunpur have been printed off in the lithographic machine from photo-lithographic transfers. The work on them was very delicate and has required very special and careful treatment. The value of the extra-departmental work was about ₹27,296, or ₹2,880 more than last year.

376. The expenditure of the office was ₹71,910, and the value of the work performed ₹66,185 or about ₹5,687 more than last year. The increase of expenditure during the year and consequent balance against the office of ₹5,724 is entirely due to large supplies of paper received from England and the Stationery Office, amounting to about ₹20,000, and required to renew stock. This amount does not, however, represent the actual expenditure for paper, because a large portion of the new supplies are still in stock. As explained in the report for 1884-85, it is found more convenient to charge for stores, &c., as received during the year and not as expended. The price of 20 large stones received during the year has also been debited in the same manner. Taking this into account, the office has worked quite profitably during the year.

377. It is very satisfactory to be able to report that the new buildings for the accommodation of the office have been put in hand during the year, and are in a forward state. In anticipation of the office being able to move into them next year, Colonel Waterhouse has urged the necessity of introducing steam machinery into the printing room in order to enable the department to meet the

increasing demands for large and small maps in colours. An indent has therefore been submitted for a large lithographic machine to print a double elephant-sized stone or zinc plate; a bevelling machine for bevelling the edges of the zinc plates to fit them to the machine or for bevelling engraved or electrotyped copper-plates; a small platen printing machine, demy folio size; an ink-grinding machine, and a suitable engine and boiler to work them. With these appliances the efficiency of the printing offices will be greatly increased, and the department will be in a position to make a good start in the new buildings.

The tabular statements showing the details and cost of the work done will be found at page xci of the appendix.*

MAP RECORD AND ISSUE OFFICE.

378. Major C. Strahan, R.E., resumed charge of this office from Major A. W. Baird, R.E., on the 4th November 1887, after his return from furlough.

Personnel.

Major C. Strahan, R.E., Deputy Superintendent, 2nd grade, and Assistant Surveyor-General, in charge.
Mr. A. E. Byrn, Head Assistant.
„ H. R. Vallis, Map Curator, and 12 clerks.
„ B. M. Wilson, Assistant Surveyor, 2nd grade, attached.

379. During the year under report the number and value of maps issued were as follows :—

Maps issued.	Number.	Value.
		₹
General maps to Government officials	62,354	39,980
Ditto to India Office, London	2,507	2,983
Ditto to Agents	1,193	1,678
Ditto to private individuals on cash sale . . .	7,077	8,970
Total . .	73,131	53,611
Cadastral maps to Government officials	1,12,525	58,182
GRAND TOTAL . .	1,85,656	1,11,793

380. There has been a slight increase in the number of the general and cadastral maps issued during the year to Government officials, but a decrease in their value, as compared with the last year's totals.

381. The actual cash sales for published maps amounted to ₹10,381, *viz.*, ₹8,970 realized from private individuals and ₹1,411 from map sale agents, while in the Revenue Section of the office 659 applications were received for extracts from original records of the Revenue Surveys, chiefly from private individuals, and 2,846 copies of village plans were supplied at a cost of ₹6,613.

382. The details of work performed are as follows :—

* Lieutenant-Colonel Waterhouse again reports very favourably of the satisfactory performance of their duties by his principal assistants, Messrs H. L. Lepage, D. Deas, and E DePyvah. Mr. S. U. Ravenscroft, the young Assistant Lithographic Printer, has done good service with the hand lithographic machine. Mr. E. Dowling has made good progress in drawing. The following native draftsmen have merited special mention :—Baboo Ambika Churn Mookerjee, Moonshis Abdul Hamid, Abdool Moojeed, Mahomed Yeasin, and Baboo Dina Nath Dass. Baboos Kedar Nath Ghose, Russick Lall Shaw and other clerks have worked well during the year. Moonshi Rukhibooddin, draftsman, retired on an invalid pension from the 8th March last, after a service of over 30 years. Baboo Chunder Coomer Sircar, writer, retired on a superannuation pension from 1st January 1888 after a service of 33 years.

Details.	Numbers.
Applications received for maps	3,520
Letters issued in reply	2,757
Cash and credit map sale bills	1,058
Invoices and receipts issued for published maps	1,628
Ditto ditto for cadastral maps	204
Ditto ditto for extracts from original records	237
Packets, parcels, and local despatches	2,411
Ditto received in the office	556
Packages despatched by rail and steamer	429
Ditto received by ditto	75
Maps colored for sale and issue	23,803
Ditto for other departments	1,552

383. It had been fully expected that the new catalogue of maps published by the department would have been completed during the year under review, but its progress has been unavoidably interrupted in consequence of the absence for nine months of one of the assistants in the Drawing office owing to ill-health. This necessitated the withdrawal of Mr. Doran, who was employed on the compilation of the catalogue, from that duty to replace the above assistant, and as no other officer was available, the preparation of the catalogue could not be continued. The work, however, is now being vigorously pushed on, and there is every prospect of its completion in the course of about six months, with the exception of the list of Burma maps which is at present held in abeyance.

A list of maps published during the year is given at page 98.*

MATHEMATICAL INSTRUMENT OFFICE.

384. Colonel D. Macdonald held charge of the Mathematical Instrument Office during the period under report, except for a short time (from 23rd July to 30th September 1888) when he was on privilege leave. During that interval Lieutenant-Colonel G. Strahan, R.E., officiated in charge.

Personnel.

Colonel D. Macdonald, B.S.C., Deputy Superintendent, 1st grade, Assistant Surveyor-General, in charge up to 23rd July 1888.
Lieutenant-Colonel G. Strahan, R.E., Deputy Superintendent, 1st grade, in temporary charge from 23rd July 1888.

Workshop Branch.

Mr. T. Bolton, Mathematical Instrument Maker, up to 9th April 1888.
„ F. Marshall, Assistant Mathematical Instrument Maker, to 8th April 1888, and Officiating Mathematical Instrument Maker from 9th April 1888.
Mr. T. R. Theakston, Assistant Mathematical Instrument Maker, from 10th July 1888.
Mr. H. Rowland officiated from 17th May to 9th July 1888 as Assistant Mathematical Instrument Maker.
64 Artificers on permanent establishment.
126 Artificers, on an average, on temporary establishment.
3 Eurasian apprentices.

Store Branch.

Mr. W. Campagnac, Officiating Instrument Store-keeper, to 4th November 1887, confirmed in the appointment from 5th November 1887.
Babu W. C. Chowdry, Material Store-keeper.

Office Establishment.

Mr. M. O'Brien, Head Clerk, retired on a superannuation pension on 5th November 1887.
Mr. C. O. Gray, Head Clerk, from 5th November 1887.
„ M. C. Belletty, 2nd Clerk, from 5th November 1887, and 6 other permanent clerks.

385. The figures given in this report refer to the financial year 1887-88, *i.e.*, from 1st April 1887 to 31st March 1888. During this period 66,299 serviceable instruments, valued at ₹2,65,487, were received into store, and 57,293 instruments, valued at ₹2,25,599, were issued on indent. The net increase to the value of the serviceable stock amounted, therefore, to ₹39,888.

* The work in this office has been carried on satisfactorily by the assistants in charge. Mr. H. R. Vallis more especially deserves credit for the way he has performed his onerous duties as Map Curator.

Photo-etching.

THE MATHEMATICAL INSTRUMENT OFFICE CALCUTTA
SURVEY OF INDIA DEPARTMENT
(Built in 1888)

Survey of India Offices, Calcutta, December 1888

386. The following tabular statement shows the principal sources from which the serviceable instruments were received:—

Source of Receipt.	Number.	Value.
		₹
From England on indent	7,387	1,16,246
By purchase in local market	31,846	35,252
Manufactured in workshop	17,960	33,320
Returned into store by public officers	1,123	9,975
From other manufacturing offices	2,156	1,195
From repairable stock after repair	5,788	68,415
From other sources	39	1,084
Grand Total	66,299	2,65,487

387. There are notable increases in two items when compared with the figures of the previous year. The first is in the value of instruments received on indent from England, which has risen from ₹47,324 in 1886-87 to ₹1,16,246. This may be accounted for by the facts that the indent for 1887-88 was considerably larger than that of the previous year, to meet the increasing demands on this office due to the extension of railways and other public works, and that, notwithstanding this increase, three emergent indents, aggregating in value ₹43,400, had to be submitted during the year to meet unforeseen demands, one being for the equipment of survey parties under the Military Mobilisation Scheme. The second item, in which a considerable increase is shown, is for purchases in the local market, which has risen from ₹8,715 in 1886-87 to ₹35,252 in 1887-88: this is entirely due to purchases made from the extra departmental grant, which is explained later on in this report.

388. During the year this office received 3,794 repairable instruments, valued at ₹44,313. The total issues from repairable stock amounted to 5,820 instruments, worth ₹43,486. Of these, 5,776 instruments, valued at ₹43,373, were repaired at a cost of ₹25,042, and transferred at the enhanced value to the serviceable stock. The repairable stock has been increased in value during the year by ₹827.

389. It may not be out of place here to record that a very large number of instruments in the repairable stock are of obsolete patterns, amounting in value to about ₹70,000 or 80,000, or say one-third of the entire value of that stock as entered in the ledgers: among the serviceable stock also there are old pattern instruments to the value of two or three thousand rupees, which no indenting officer will accept. These instruments are the accumulation of many years, and consist mainly of 5″, 6″, and 7″ theodolites and 10″ to 20″ levels, mounted on 4 foot-screws, besides a quantity of old meteorological instruments, such as barometers, anemometers, &c. The improvements both in design and construction of instruments of late years has been very rapid, and in some cases they differ entirely from the original patterns. Most of the instruments alluded to are either faulty in design, or of inferior construction, or both combined. These instruments continue from year to year accumulating on our hands, and occupy a large amount of valuable space. The time has now come when some decision must be arrived at as to what is to be done with these instruments, and it is intended shortly to convene a committee of departmental officers to report on them, and to submit recommendations as to their final disposal.

390. During this financial year 66,299 serviceable and 3,794 repairable instruments have been received into store, making a total of 70,093 instruments. The corresponding number for the previous year was 43,289, which shows an increase of over 50 per cent., and represents a corresponding increase in clerical labour in passing them through the ledgers. The issue too of serviceable instruments has increased from 37,391 in 1886-87 to 57,293 in 1887-88. From these figures it is evident that the work of this office continues steadily increasing, for every serviceable instrument issued has to be carefully examined and tested, and every instrument, whether serviceable or repairable, which is received into store, has to be carefully examined and its value appraised.

391. Table A (page xcvi of the appendix) shows the amounts of the debits against various offices and departments for instruments supplied and work done. It also exhibits the credits for all instruments and materials returned to store. The value of issues and repairs executed has risen from R1,87,377 in 1886-87 to R2,32,257 in 1887-88, that is to say, by R44,880. This increase, however, includes R25,000 spent on instruments in the local market from the extra departmental grant which is explained below. Thus the net increase is reduced to R19,880. The credits for instruments returned has again fallen: it amounts to R55,455 as against R87,253 in 1886-87. The cash sales have diminished from R6,893 in 1886-87 to R4,545.

392. During the previous year, 10,343 instruments were purchased in the local market for R8,715: in the year under review the number has increased to 31,846, and the value to R35,252. If R25,000, expended from the extra departmental grant, be deducted from this last sum, it leaves the figures for 1887-88 at R10,252, which is much the same as the amount similarly expended in 1886-87. Table B, showing the details of these purchases, will be found at page xcvii of the appendix.

393. Some explanation may here be given of the "extra departmental grant" previously alluded to, as affecting the figures in tables A and B. Up to October 1887 it had always been the custom, when any indents were received for instruments which could not be supplied from stock, to call on the indenting officer to furnish this office with funds for the purchase of the instruments required in the local market. The instruments so purchased were not passed through the office ledgers, but were charged to Government by the indenting officer in his contingent bills direct. Thus the funds which passed through the hands of this office as agent for these local purchases were not brought to account in the books thereof. The Government, considering that cash transactions between public offices are objectionable in principle, have ruled that in future, transactions of this nature should cease; that all money thus expended by this office should be brought to account therein; and that the instruments should be issued in the usual manner on book debit.

394. It was necessary, under the circumstances, to procure funds for these local purchases, as no provision had been made for them in the budget estimates of this department. A grant termed "extra departmental" was then sanctioned. All expenditure from this grant is brought to account in the books of the office, and at the end of the financial year, when the accounts of the twelve months are finally made up, this office is directly credited with the amounts so expended by the deduction thereof from its total expenditure. It will be evident, therefore, why the expenditure on local purchases shown in table B is so much in excess of that of the preceding year.

395. The number of instruments which have been manufactured in the workshops is larger than that of the previous year, and their value considerably greater. The figures are given below:—

	No.	Value. R
1886-87	9,545	23,450
1887-88	17,960	33,320

The class and value of these instruments will be found in table C (page xcix of the appendix).

396. The number of principal instruments repaired in the workshops is 1,724 which is a slight falling off, the number for the previous year having been 2,086. The total number of instruments repaired amounts to 3,012 against 2,491 in 1886-87. (*Vide* table D, at page ci of the appendix:)

397. The Profit and Loss account of the workshop will be found at page of the appendix. On the whole, it shows that the amount of work done represents a larger money value than the account of the previous year by R6,702, the figures being R67,404 for 1886-87 and R74,106 for 1887-88. The principal increase is in the manufacture of instruments for stock: there is a slight decrease in the value of repairs to stock, while most of the other items are about the same as in the last year's account.

398. The new building that has been erected by the Public Works Department for the accommodation of this office is now occupied. The ceremony of cutting the first sod was performed on the 31st May 1887. In the beginning of June 1888 some of the rooms were ready for occupation, and by the end of July

1888 all the stores, machinery, and plant had been transferred from the old quarters. The new Mathematical Instrument Office is a handsome structure, with fairly ample accommodation for the present establishment of workmen, stores, &c. It has been provided with an Observatory on the roof, in which a transit instrument has been set up and is now used regularly for rating chronometers. The old boiler, which had been in constant use for 20 years, has been replaced by one procured from England, which is considerably larger and more powerful, and fitted with all the latest appliances. The steam engine could not be utilised in the new office till quite the end of October 1888, owing to the shafting being deficient: this naturally somewhat retarded the work and diminished the out-turn. All the shafting, &c., is now completed, and every thing is in good working order.

399. The house formerly occupied by this office had to be somewhat hurriedly vacated: it was one of the oldest houses in Calcutta, and had been admitted for many years to be in a somewhat shaky and dangerous condition At the beginning of June 1888, however, some of the beams at the east end of the building showed unmistakable signs of collapse; so the office and workmen in that wing were at once transferred to the new building, which was fortunately sufficiently advanced to receive them. After this it was deemed prudent to stop the working of the steam engine, and to remove the rest of the office as speedily as accommodation could be provided in the new building. Eventually, when the old house was dismantled and pulled down to make room for the new Lithographic Office which is to occupy its site, it was found that there were very few sound beams in the house, the large majority having been gutted by white ants. It was a fortunate circumstance that the house with its valuable contents did not collapse before it was vacated.

400 During the last 12 months the art of cutting stencil plates has been very successfully introduced in the workshop. Two small (5″) theodolites have been manufactured, *ab initio*, in the workshops, as well as heliographs and prismatic compasses. These instruments are imported, as a rule, from England, and were only manufactured on this occasion for the instruction of apprentices, who are now fairly well advanced in their education.

401. On a representation being made to the Government of the insufficiency of the permanent workshop hands to cope with the current work of the office, the contingent grant of ₹300 per mensem for the payment of temporary workmen, which had been sanctioned as a temporary and tentative measure, was made permanent, and a further grant of ₹150 per mensem for the same purpose sanctioned as a tentative measure for three years. This was an absolute necessity in view of the increasing amount of work thrown on this office. Even with all this aid it is found that very little progress can be made in the way of reducing the stock of repairable instruments, the current work being so heavy and urgent.

402. Some new instruments have been lately imported, and several improvements, suggested by lately gained experience in trans-frontier work, have been adopted in the latest additions to the stock.

403. Mr. Bolton, the Mathematical Instrument Maker, was granted three months' privilege leave in July 1887 with the object of recruiting his health. He was, however, ultimately obliged to take two years' furlough to Europe in April 1888, his application being supported by a medical certificate On both occasions Mr. Marshall, the Assistant Mathematical Instrument Maker, officiated for him; but, as he could hardly be expected to carry on the supervision of the workshop single-handed, an application was submitted to the Secretary of State for the services of a qualified mechanic from one of the great firms of instrument makers in England. In July 1888, Mr. T. R. Theakston, from the well-known firm of Cooke & Co., York, arrived under a two years' agreement. For the interval it was found necessary to enlist the services of a local mechanical engineer to assist Mr. Marshall in his duties.*

* Colonel Macdonald reports that Mr. T Bolton, up to the time of his departure, superintended the workshop with his usual ability. Of the other officers he remarks: "I consider Mr. Marshall an exceptionally good mechanic, well versed in all the branches of his profession: he is also a good manager, and a hard-working and intelligent officer. Mr. Theakston appears to have been well grounded in his profession: he is intelligent, and has been working well and steadily since he joined this office. Mr. H. Rowland, who was temporarily employed, though not specially trained for the kind of work required, gave material assistance during the short time he was attached to the office.

The clerical establishments are very favourably reported on, and the names of Mr. Gray and Mr. Campagnac are specially brought to notice for steadiness and efficiency.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

404. The constitution of this office has remained as heretofore, consisting of the following sections:—

(1) Correspondence, Accounts, and Records.
(2) Computing.
(3) Type-printing.
(4) Drawing and Compiling.
(5) Photozincography.
(6) Solar Photography.
(7) Miscellaneous, Meteorology, &c.

405. The principal section of this office is the computing branch, which deals with the final reduction and publication of the triangulation of all parts of India, comprising the principal and secondary operations of the Great Trigonometrical Survey. This work obviously involves other technical requirements to that of computers, and accordingly three small auxiliary sections for printing, drawing and photozincography were constituted to work in concert with the calculating section, and the four sections thus constituted form what is called the computing party. Without these auxiliaries, which make it independent of all extraneous assistance in the matter of publication, the accuracy of the technical details could not have been well maintained. The office has also a depôt of instruments and stores attached to it, appertaining to the Great Trigonometrical Survey, of which it has long been the head-quarters, and it is the receptacle of the equipment required for survey operations beyond the frontier, which has now to be maintained on a large scale. It is the place where trans-frontier explorers are trained, and it affords facilities for training departmental and other officers in taking astronomical observations and in the use of instruments of the higher class; it furnishes also the means for taking experimental observations and making investigations in connection with the scientific work in which the trigonometrical branch still continues to be engaged. The great strides that have been made during the last few years in our knowledge of trans-frontier geography has thrown a vast amount of urgent work on the drawing office of the department which it would have been impossible to cope with without the succour which the drawing section at this office has been able to afford, and it has been found of immense advantage to have such an ally to meet this extra strain. Full details of all the operations of the office are given in the appendix, a short account of some of which will be here given.

Personnel.

Colonel C. T. Haig, R.E., Deputy Surveyor-General, in charge Trigonometrical Branch.
Lieutenant-Colonel T. H. Holdich, R.E., Deputy Superintendent, 3rd grade, in charge Drawing Section, from 14th April 1888.
Major St. G. C. Gore, R.E., Deputy Superintendent, 4th grade, till 14th February 1888.
Mr. W. H. Cole, M.A., Deputy Superintendent, 3rd grade, in charge Computing Party, to 5th January 1888.
Major M. W. Rogers, R.E., Deputy Superintendent, 3rd grade, in charge Computing Party, from 6th January to 9th April 1888.
Lieutenant S. G. Burrard, R.E., Officiating Deputy Superintendent, 4th grade, in charge Computing Party, from 10th April 1888.
Mr. J. Eccles, M.A., Assistant Superintendent, 1st grade, till 1st November 1887.

(1) *Correspondence, Accounts, and Records.*

Mr. F. A. D'Rozario, Head Clerk.
Babu Mizaji Lall, and four other Native Writers.

(2) *Computing.*

Mr. C. Wood, Surveyor, 1st grade.
„ H. W. Peychers, Surveyor, 3rd grade.
Babu Gunga Pershad, Computer.
„ Cally Mohun Ghose, Computer.
„ Kally Koomar Chatterjee, Computer, and 15 other computers.

(3) *Type-printing.*

Mr. B. V. Hughes, Printer.
17 compositors and apprentices.

(4) *Drawing and Compiling.*

Mr. A. J. Wilson, Surveyor, 1st grade, up to 13th March 1888.
Mr. G. W. E. Atkinson, Surveyor, 1st grade.
Mr. E. S. P. Atkinson, Surveyor, 2nd grade, from 17th April to 31st May 1888.
Mr. N. C. Gwynne, Surveyor, 3rd grade.
Mr. C. H. McA'Fee, Surveyor, 3rd grade.
Mr. T. H. Rendell, Surveyor, 4th grade.
Mr. W. J. Cornelius, Officiating Surveyor, 4th grade.
Mr. H. T. Kitchen, Assistant Surveyor, 1st grade, from 1st September 1888.
Mr. J. Keating, Assistant Surveyor, 1st grade.
Khan Bahadur Yusuf Sharif, Assistant Surveyor, 3rd grade, from 6th June 1888.
Sub-Surveyor Abdul Aziz, from 1st May till 1st July 1888.
Mr. H. Sindon, and six other draftsmen.
23 Assistant and Apprentice Draftsmen, and Colourists.

(5) *Photozincography.*

Mr. C. G. Ollenbach, Zincographer.
2 Assistant Photographers, 2 Native Draftsmen, 1 Assistant Draftsman, and 1 Mapkeeper.

(6) *Solar Photography.*

Mr. C. F. Guthrie, Assistant Solar Photographer.

406. COMPUTATIONS.—The chains of triangles, although executed with the best instruments available which were used with the utmost care and precision, were still, like all human undertakings, imperfect; and their imperfections appeared when a chain closed on a measured base-line or one chain met another, by small discrepancies showing themselves in the length of side and in the co-ordinates of the stations. The first great undertaking of the computing section was the rendering into one harmonious mass the principal triangulation of India between the meridians of 67° and 92° by the most approved mathematical processes, *i.e.*, by "the method of least squares." The triangulation was too extensive to render it possible to manipulate the whole at once, and moreover at the time the reduction was commenced, *i.e.*, about the year 1867, several chains still remained to be executed and two base-lines to be measured. The triangulation was accordingly divided up into five large sections, designated the North-West, North-East, South-West and South-East Quadrilaterals and the Southern Trigon; and these large figures were successively reduced. The whole has now been rendered consistent *inter se*, so that the correct length of every base-line is reproduced by the triangulation from any other base-line, and no circuit, however chosen, shews any closing error.

407. The results of the preceding calculations have been published as follows:—The measurements of the base-lines in Volume I of the Operations of the Survey; the North-West Quadrilateral in Volumes II, III, IV and IVA; the South-East Quadrilateral in Volume VI; and the North-East Quadrilateral in Volumes VII and VIII. Considerable progress has been made in the past year with the printing of the results of the remaining two large sections of the triangulation, *viz.*, the South-West Quadrilateral and the Southern Trigon. In connection, however, with the principal triangulation, a great deal of subsidiary or *secondary* triangulation is always executed, chiefly with minor theodolites, for the purpose of fixing the positions of important towns, of conspicuous buildings, &c., to afford data for the topographical delineation of the country. This triangulation has also to be rendered consistent with the principal triangulation, and though much yet remains to be disposed of, a very large quantity has been finally reduced. All that appertains to the North-West and South-East Quadrilaterals has been finished, and the results have been published in Synoptical Volumes; one, *viz.*, Volume $\frac{1}{B}$ which contains the results of the Survey Operations with the Afghan Boundary Commission having been completed and published during the year. Of the North-East Quadrilateral, only the secondary triangulation of two series remains unpublished, *viz.*, that of the North-East Longitudinal Series and the Assam Longitudinal Series. The former has not yet been taken in hand owing to the field operations not being complete; the latter, which was to include the work as far east as the extreme north-east frontier, is in hand; but owing to the extension of the Principal Triangulation into Upper Burma, it has very recently been decided to include the Assam Valley Triangulation for simultaneous reduction with the entire triangulation east of 92°, so as to give it the benefit of the small corrections which such reductions show to be due to the various parts of its components. Up to the present time, 24 Synoptical Volumes have been published containing the data of 34 series of triangles suitably arranged for the use of detail and other surveyors. The Southern Trigon embraces almost the whole of Colonel Lambton's net-work of triangulation, which is now treated as secondary, besides the secondary triangulation connected with each series. Much of Colonel Lambton's triangulation has been reduced to final terms during the year, and the computation of the whole of the secondary triangulation appertaining to one of the series thereof, the South Konkan Coast, is practically disposed of. The secondary triangulation of the South-West Quadrilateral has not yet been taken in hand.

408. The final reduction of the astronomical latitudes was undertaken in 1879, and by the commencement of 1887 all the observations from Lambton's time to 1884-85 had been reduced, and considerable progress had been made with the preparation of the results for the press. The progress since made has been the completion of the press copy, the writing of the explanatory chapters, and the printing of more than 400 pages of the results and 22 pages of the chapters. The electro-telegraphic longitude operations, which are carried out by Astronomical Parties Nos. 1 and 2, are reduced year by year by those parties aided by two computers lent by this office during the recess season. The

results when ready for the press are made over to this office to be printed. One volume of the results, *viz.*, Volume IX of the Operations, &c., was published in 1883; a second volume, numbered X, has now been completed and issued; it contains operations up to season 1883-84, inclusive; a third volume has also been commenced. The results of spirit-levelling operations, carried out by the Tidal Party, are sent to this office for publication. During the year, pamphlets Nos. 2 and 3 of Levels in the Madras Presidency have been published and issued; the former covering the country from Madras, *viâ* Negapatam and Pámban to Tuticorin near Cape Comorin, and the latter from Tuticorin *viâ* Madura and Trichinopoly to Erode, with branch lines from Trichinopoly to Tanjore and Shoranúr to the Cochin Tidal Station, and from Kárwár to Mormugáo Tidal Station.

A catalogue of the books in the Library has been compiled, and nearly all the pages passed through the press.

409. DRAWING AND COMPILING.—The preparation of the new trans-frontier maps embodying the surveys of the Afghan Boundary Commission has continued to employ the majority of the staff of this section during the year under review, and owing to its importance and magnitude it has been found necessary to employ an officer of skill and local experience in supervising these compilations. Major Gore, R.E., was entrusted with this duty till 14th February 1888, and subsequently Colonel Holdich, R.E., has superintended this work. Triangulation charts in connection with the same series of maps have also been prepared for the special synoptical volume dealing with the north-western trans-frontier. This special and large undertaking has interfered a good deal with the advance of ordinary work, which has necessarily been kept somewhat in abeyance. But some progress has been made in this class also. Amongst the compilations that have been completed, the most important are those of explorers' work in Bhutan, Tibet and the Lower Sangpo, and the route taken by Lieutenant F. E. Younghusband from Pekin to Kashmir. Among the miscellaneous work may be mentioned two sheets of level charts and a new edition of the large scale guide map of Mussooree and Landour.

410. SOLAR PHOTOGRAPHY.—Photographs of the sun have been taken daily throughout the year for the Solar Physics Committee, South Kensington, except when the sun was invisible. In all thirty-eight days were lost. These photographs serve to largely supplement the series taken at Greenwich, and their results are included by the Astronomer Royal in the yearly volumes of the Greenwich Observations.

411. METEOROLOGY.—The tabulated results of the meteorological observations show the effect of the improvements introduced for the better supervision of some of the earth thermometers and the prevention of convection currents referred to in paragraph 375 of the last Annual Report. This is apparent in the slightly increased uniformity of the figures.*

LIST OF MAPS AND CHARTS PUBLISHED DURING THE YEAR 1887-88.

TITLE.	Scale.	Number of sheets.	REMARKS.
ATLAS OF INDIA.	In. M.		
Quarter Sheets Nos. 12 N.W., 19 S.E., 23 S.E., 39 N.W., 39S .E, and 114S.E.	1=4	6	
Sheet No. 65	1=4	1	With additions to 1884.
GENERAL MAPS.			
India, skeleton	1=48	4	Prepared for Secretary of State.
Do. do.	1=64	2	Reduced from above.
South-West Asia, Sheet No. 72	1=8	1	

* The officers in charge of the several sections of the Trigonometrical Branch Office report favourably on most of their assistants, making prominent mention of Messrs. Wood, Atkinson, McA'Fee, Ollenbach and Hughes, who stand at the head of their respective sections; also of Messrs. Peychers, Cornelius and Sindon. Testimony is also borne to the ability and energy of Babus Gunga Pershad, Kally Mohan Ghose, Amba Pershad, Kally Coomar, and the other computers.

Title.	Scale.	Number of Sheets.	Remarks.
Provincial Maps.	In. M		
Mysore	1=16	1	Preliminary Edition in outline.
North-West Provinces and Oudh	1=32	1	With corrections and additions to January 1888.
Sketch Map of the Province of Bengal, Behar, Orissa, and Chota Nagpur	1=16	2	
Part of Upper Burma	1=8	3	Preliminary Edition.
District Maps.			
Budaun	1=2	2	
Moradabad	1=2	2	
Jubbulpore	1=2	1	2nd Edition.
Sonthal Pergunnahs (Bhagalpur Division)	1=4	1	
Burdwan	1=4	1	With corrections and additions to January 1888.
Nowgong	1=4	1	With corrections and additions to May 1887.
Moorshedabad	1=4	1	With corrections and additions to November 1887.
24-Pergunnahs	1=4	1	With corrections and additions to December 1887.
Akyab	1=8	1	Reduced from the old map on $\frac{1}{4}$" scale.
Standard Maps.			
Andaman Islands.			
Sheets Nos. 3 and 11	1=2	1	
Bombay.			
Sheets Nos. 52, 53, 70, 71, 72, 73, 86, 87, 88, 89, 103, 119, 134, 168, 172, 173, 182, 187, 191, 199, 214, 215, 216, 227, 260, 275 and 276	1=1	27	
Sheets Nos. 214 N.E., N.W., S.E., and S.W., and 215 N.E., N.W., S.E., and S.W.	2=1	8	
Burma (Trans-Frontier Series).			
Sheets Nos. 1 N. E., 2 N. E., 2 S. E., 3 N. E., 4 S. W., 5 N. W., 5 S. W. and 6 N. W.	1=4	8	2nd Edition.
Sheet No. 15 S. E.	1=4	1	2nd Edition.
Burma (Lower).			
Sheets Nos. 141, 183, 186, 231 and 232	1=1	5	
Sheets Nos. 125 N. E., N. W., S. E. and S. W.	2=1	4	Preliminary Edition.
Sheets Nos. 227 $\frac{\text{N. E.}}{1}$, $\frac{\text{N. E.}}{3}$, $\frac{\text{N. W.}}{4}$, $\frac{\text{S. E.}}{1}$, $\frac{\text{S. E.}}{2}$, and $\frac{\text{S. W.}}{4}$, and 227 $\frac{\text{N. W.}}{1}$	4=1	7	
Central India and Rajputana.			
Sheets Nos. 76, 253, 385, 386, 388, 402, 403, 404 and 405.	1=1	9	
Half Degree Sheet No. VIII North, Sheets Nos. 38, 39, 53, and 54	1=2	1	
Half Degree Sheet No. VIII South, Sheets Nos. 40, 41, 55, and 56	1=2	1	
Nicobar Islands.			
Sheets Nos. 1, 2 and 3	1=2	3	
Sheet No. 2 (Kamorta Settlement)	4=1	1	
North-West Trans-Frontier Series.			
Sheet No. 3	1=8	1	
North-West Provinces.			
Sheets Nos. 37 (2nd edition), 56a, 183, 195, 196, 201, 210, 211, 218, 219, 220 and 221	1=1	12	
Sheets Nos. 168 N. E., S. E., 181 N. W., S. W., 200 N.W., 201 N.E., N.W., and S.W.	2=1	8	

Title.	Scale.	Number of Sheets.	Remarks.
Standard Maps (*continued*).	In. M.		
Oudh.			
Sheets Nos. 102, 116 and 117	1=1	3	
Punjab.			
Sheets Nos. 252, 261, 266 and 268 (Preliminary Edition)	1=1	4	
Sheets Nos. 160 N.E./3, N.E./3 and 4, S.E./1, S.E./2, S.E./3, and S.E./4, 161 N.E./1, N.E./2, N.E./3, S.E./2, S.E./3 and S.E./4, 162 N.E./1, N.E./2, N.E./3 and N.E./4, 183 S.W./3, 185 S.W./2, S.W./3 and S.W./4, 186 N.W./1, N.W./2, N.W./3 and 4, S.W./1 and 2 and S.W./3 and 4	4=1	25	
Plans of Cities and Cantonments.			
Rangoon	16=1	1	Corrected to 31st March 1887.
Gorakhpur	12=1	4	
Mussooree and Landour	8=1	1	
Ruins of Pagan	6=1	1	
Mandalay	6=1	3	
Jeypore and environs, including Amber	6=1	8	Published in 1886.
Statistical Maps.			
India showing Railways, to January 1888	1=32	6	
Do. do. Canals, 1887 (Preliminary)	1=32	6	
Do. do. percentage of cultivated area of rice	1=64	2	
Do. do. do. do. cotton	1=64	2	
Do. do. do. do. wheat	1=64	2	
Do. do. do. do. sugarcane	1=64	2	
Miscellaneous Maps.			
Kerowlee State	1=4	1	
District of Astor, Kashmir (shooting ground)	1=4	1	
Nicobar Islands (Mercator's Projection)	1=5	1	
Jeypore State	1=8	1	
Hooghly River Survey, Sheets Nos. 4, 6, 7, 9 and 10	3=1	5	
Sketch Map to illustrate Colonel Tanner's memo. on the course of the Sangpo	1=12	1	
Sketch Map to illustrate Colonel Tanner's memo. on Bhutan and Tibet	1=12	1	
Triangulation Charts.			
Baluchistan Survey, Part of Sheet No. 21 S.E./1, season 1885-86	1=2	1	
East Coast Series, Nos. 5, 6, 7, 12 and 13, seasons 1884—87	1=2	5	
Mirzapur Survey, seasons 1881-87	1=4	1	
Central Provinces Survey, seasons 1886—88	1=4	2	
Nicobar Survey, season 1886-87	1=8	1	
Kubo and Chindwin Valleys Survey, season 1886-87	1=8	1	

APPENDIX.

EXTRACTS

FROM

REPORTS BY EXECUTIVE OFFICERS.

SECONDARY TRIANGULATION.

COROMANDEL COAST.

Extract from the Narrative Report of MR. E. C. RYALL, *in charge No. 24 Party—Season 1887-88.*

The party reached Madras on the 15th November, but owing to heavy rain and the generally unfavourable weather which ensued from that time till the beginning of January, the field operations could not be commenced till the 10th January. Twelve miles of the coast line were then prospected. The aspect of the coast was found to be very much against carrying on an unbroken chain of triangulation along it; and to effect it would have entailed expense out of all proportion to the object in view. From almost the very water's edge to a distance of from 3 to 4 miles inland, the whole tract, for the most part, was found densely covered with forests of Casuarina plantations (the trees averaging about 50 feet in height) and gardens of palmyra, cocoanut, and other fruit trees. I was informed that the coast presented the same characteristic features all the way down to Pondicherry and Cuddalore: so that were the venture of conducting triangulation successful, the beacons erected along such a coast line would be next to useless for the marine survey on account of the dark background of high trees which they would have when viewed from the sea. Under the circumstances I abandoned this project and turned my attention to the hills.

The Great Trigonometrical stations of St. Thomas's Mount, Tirumani, and Avirimodu were visited in succession. These hill points were 235, 750, and 470 feet respectively above sea level. Lying between these and the coast, and at an average distance of 7 miles from it, I found scattered here and there hill peaks previously fixed by the East Coast Series. Some of these peaks were capped with imposing-looking temples, many of them half in ruins. The hills ranged in height from 325 to 470 feet, and as some of them would be easily and prominently visible from 10 to 15 miles out at sea, I selected such of them as were more conspicuous from their isolation, sharpness and height. Three such untempled peaks had beacons built on them—two consisting of solid masonry presenting a broad face towards the sea, and one of a wooden superstructure embedded in a masonry foundation. Three other temple-capped peaks were made prominent by having the seaward faces of the temples cleaned and whitewashed. Besides utilizing these natural prominences the position of Tiruporur reef light-house was determined and a wooden beacon now marks the mouth of the Pálar river. Including Kovalam (Covelong) church and Pondicherry flagstaff, fixed from the East Coast Series, there are 11 marks, whose latitudes and longitudes have been accurately determined, all of which, I feel no doubt, will be of use to the Marine

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Survey Department. Thus the work was carried practically up to the neighbourhood of Cuddalore.

I would have left Cuddalore alone, but for the misgivings I had as to whether the Cuddalore flagstaff, which was fixed by Colonel Lambton some 90 years ago, is identical in position with the one now standing. Of course, the traditionary evidence was conflicting, and I found it was necessary to re-fix it by running a series of triangles from the nearest base of the Madras East Coast Series—that of Vallam and Seppalánattam Trigonometrical stations. Ten triangles, the sides of which were from the nature of the country short, were required for this purpose.

Porto Novo flagstaff after much difficulty was then fixed, over 20 days having been spent in its determination: rays from 21 to 10 miles long had to be cleared. Unfortunately a few years ago the lofty chimney of the iron foundry, 142 feet high, tumbled down in huge pieces, covering with its *débris* an area some 40 yards in diameter; otherwise it would have been an easy matter to have fixed the flagstaff by a short traverse of three quarters of a mile therefrom. I excavated with a view to get even an approximate idea of the position of the centre of the chimney, but with no satisfactory result.

The Porto Novo-Tranquebar Series was next taken in hand and completed by the 10th May. As Kárikál (Carrical), Nagore, and Negapatam had been previously laid down by the Negapatam Minor Series, an offshoot of the Madras East Coast Series, the secondary triangulation was practically completed down to Negapatam.

Before continuing further the description of the southern part of my work, I shall briefly describe the work carried on northward from Rámapatnam, where, as has already been reported, I was, owing to sickness, compelled to stop work on the 18th May 1887. Mr. Bond was deputed to fill up the hiatus between Point Devi and Rámapatnam, some 80 miles in all. He appears to have had much trouble, and though he carried on the work slowly and seemed despondent about it, he nevertheless went through it all right. He succeeded in planting 6 beacons, the last one at the most easterly end of the promontory at the mouth of the southern branch of the Kistna river. The work was of a very arduous nature, and Mr. Bond performed it very creditably. His services were lent to Colonel Strahan, R.E., from the end of October to the end of January, to help in a piece of triangulation with a view to fixing the longitude of Nagarkoil station near Cape Comorin.

On completing the Porto Novo-Tranquebar Series, I received orders to continue the triangulation southwards to Point Calimere, with instructions that, should it appear to me that gardens or otherwise forest-clad tracts would probably impede progress, or, if the undertaking promised to be costly, I should run a traverse with theodolite and chain down to that point and back, in lieu of triangulation. The latter alternative was adopted, as likely to be less expensive, if not more expeditious. As traversing was to be substituted for triangulation, it became necessary to use every precaution against error factors, one of them being the unit of measure, to eliminate which, it became absolutely necessary that the traverse should be closed on another Great Trigonometrical point than the initial one of origin. The traverse lines were carefully dressed, the boundaries of fields were levelled, and where natural mounds were met with a clinometer was used for reducing the measurements to the horizontal plane. On the first day the chains were tested three times against standard bars, on the second day twice, and, for five days after, once each day. When the chains showed no material signs of change, the intervals between testing days was increased. At each testing station a base of 200 feet was measured with the standard bars, and as a further precaution, the chains were tested against this base. Three chains of different units were employed—one of 66 feet, another of $100\frac{1}{8}$ feet, and the third of $95\frac{7}{8}$ feet. The angular measurements were also well checked by numerous observations for azimuth. I felt myself well rewarded for taking these precautions, for, on closing on Patukota Great Trigonometrical station, after a run of 32,000 chains or 60 miles of main traverse, the discrepancy was found to be 1-14th per *mille*, or about 4 inches per mile, a result no doubt in some measure fortuitous. The co-ordinates were computed with azimuths to the nearest second, and the distances were recorded to the nearest inch. Besides the above main traverse, 4 sub-circuits, aggregating 17,950 chains or 34 miles, were traversed for fixing positions of beacons and of the masonry structures and temples which existed on the sea coast and neighbouring hill peaks, and which were suitable to serve as beacons. Other hills conspicuous from the sea-board had masonry beacons erected on them and along the sea coast wooden beacons were put up.

It may not be considered out of place to give a description of one of these wooden structures employed during the season under report, on sandy and other mixed soils incapable of bearing a solid structure of masonry. The beacon consists of a solid post of Moulmein teak wood, squarely cut 8″ × 8″, standing above the surface of the ground to a height of 33 feet, and having two pairs of cross arms of planking inserted into it. The smaller pair is let in 8 inches below the top of the post and the larger 5 feet below this again. The post is embedded in a block of countersunk masonry 6 feet deep, 6 feet square at foundation, and 5 feet square at surface of ground. A sloping superstructure of masonry from the surface of the ground, to a height of 4 feet, braces the post.

In the countersunk portion of masonry, and about 8 inches above the concrete foundation, a large teak-wood block about 5 feet long and 19 inches both in depth and width, is let in, having underneath it two solid slabs of wood 5′ × 18″ × 9″ each, at equal distances from its centre. The receptacle on the surface is cut 9 inches deep, into which

is inserted tightly the end of the post. This arrangement of the wood-work was introduced in order to distribute the vertical pressure of the upright post over an area nearly 40 times larger than that of the surface at the end of the post.

The arms, and five feet of the post below the lower ones, have been painted white, the rest of the post red. The countersunk portions of the post and wood-work are tarred. The post is marked with a broad arrow and the following inscription:—G. T. S., 1888.

HIMALAYAS, PUNJAB.

Extract from the Narrative Report of COLONEL H. C. B. TANNER, *in charge No. 18 Party—Season 1887-88.*

Demarcation of Forest Boundaries.—The state of the demarcation of forest blocks and the difficulty of finding the boundaries on the ground has continued to give a great deal of trouble. The difficulties are due partly to the intricate nature of the ground, and partly to the small size of the boundary cairns, which often consist merely of a few loose stones piled up; also, in a great measure, to the ignorance of the native officials whose duty it is to point out the boundaries to the surveyors. In Seoráj (Kullu), we have now executed two complete sets of forest surveys, the maps of which, when compared, shew serious discrepancies, and from what I have subsequently learnt, I have to report that even after the completion of the second survey operations we have failed in many cases to secure the correct forest boundaries. The forest demarcations appear to be carried out on no fixed system. In some cases the cairns are so unnecessarily close together that we are unable to plot them on the 4-inch maps, and in others they are so far apart that practically the demarcation may be said to exist on paper only. Faulty forest demarcations have been found by me throughout the Himalayas, in Darjeeling, in Kullu and in Kángra, where a boundary runs across the drainage of a great mountain; in a number of cases it has been thought sufficient in practice to leave the line crossing a valley to itself, and by the erection of cairns on two adjoining spurs, sometimes separated from each other by a valley several hundred feet deep, the demarcation of the line is considered to have been completed, for a line on the map between the two spurs catches the eye and is then called a boundary, when in fact there is not the slightest indication made on the ground corresponding to this straight map line: thus, at the bottom of the valleys where there should be marks, there is no clue to the grazier or woodman as to where the supposed boundary crosses them. This system of supposed or map-demarcation gave rise in Darjeeling to many disputes which were only settled after the straight map lines had been cut through the jungle and afterwards demarcated with pillars. The same drawbacks will sooner or later become evident in Kángra and Kullu, where this system of faulty demarcation has been pursued, and I, therefore, bring the matter to notice, so that, if it be possible, the faults may be remedied before disputes as to forest rights arise.

Mauza and Tikka Demarcation and Survey.—Our orders with respect to the survey of *mauza* boundaries and *tikka* tri-junction pillars are these:—to survey the general run of the former, neglecting boundary marks, and to fix with theodolite such of the *tikka* tri-junction pillars as are not situated in very high mountainous tracts. Throughout the Bengal Presidency, except in the Himalayas, the surveyor meets with permanently marked tri-junctions which he can readily identify as such, but in Kángra and Kullu there are no distinguishing marks whatever at these obligatory points. The result is that the traversers and plane-tablers waste a great deal of time listening to the arguments of the *lumbardárs* and *patwáris* as to which of a numerous set of cairns is the tri-junction sought. There being no distinguishing mark thereat, the surveyors are very often mis-informed by persons who, through ignorance or design, point out the wrong mark. I do not wish it to be understood that permanently marked tri-junction platforms are entirely absent in Kángra and Kullu, but as a rule they are wanting, and our surveyors are daily put to the greatest inconvenience from the difficulties they meet with in ascertaining the position of points they are required to fix. Mr. O'Brien, Deputy Commissioner of Kángra, has now arranged that in those tracts of his district where we are to undertake a traverse survey, he will erect at the tri-junctions large cairns with a stout post in the centre of each, so that in future there will be no difficulty in identifying them. The insufficiency of the forest demarcations, combined with the absence of distinguishing marks at the tri-junctions, has materially enhanced the cost-rates, and rendered the prosecution of the work a very irksome task to the assistants of the party and to myself. In Kullu there has been great friction between the civil administration and the Survey party, but on my representing the matter to the Financial Commissioner, an arrangement has been arrived at by which the difficulties hitherto attending the surveyors will be lessened. In this connection I wish it to be understood that I have no complaint to make against the Forest subordinates, who, to the best of their ability and knowledge, have worked well with the survey squads.

Proposed further demarcation of Forest Blocks.—Since writing the above, I have met the Inspector General of Forests and the Surveyor-General in consultation regarding the difficulties under notice, and it is now arranged that trees on the forest boundary lines shall be blazed at short intervals, so as to serve as a guide to the shape of the forest blocks. We shall now be in a position to obtain a correct map of the shape of the forest blocks

and if we here and there miss a cairn, it will be a matter of no great consequence. The blazed lines will be capable of identification for years to come, and the Forest officials, at any reasonable interval of time hence, will be able to demarcate them according to departmental requirements.

Bar-subtense Traverse Survey.—The results obtainable by the bar-subtense method of traversing, which has been employed for three seasons, are now shewn to have reached the probable limit of accuracy. The traverses, for the most part, are based on trigonometrical co ordinates and shew a mean closing error of 2·5 feet per mile, and considering that the work has been carried over precipitous mountains, and slopes covered with rocks or forest, the system, which is both expeditious and simple, may be regarded as a complete success. It must be remarked, with reference to the above closing error of 2·5 feet per mile, that an error of a tenth of an inch in a 20-feet bar gives an error of 2 feet per mile: it is evident therefore that the bamboo bars used must have been very near the assumed length; but had they been very wide of the truth, the system of basing the work on true rectangular co-ordinates would have served to eliminate the error derived from such a source. While the co-ordinates are so near the truth as here reported, it must be noticed that the angular error that obtained is far greater than is generally admissible in the Revenue Branch. In three of the traverses it is so high as one minute in three angles; in eleven traverses the angular error is zero; in five cases the correction is one minute per angle, and in three cases one and a half minute per angle; but even in the worst cases the closing error of the traverses only amounts to 2½ feet per mile. This angular error is chiefly due to the difficulty of truly centering the bar over the forward station dot, and it seems surprising that with angular errors so unusually large, the co-ordinates resulting from such work should be so correct. It must be remembered that in using the bar a surveyor is always in a position to ascertain the correctness of the length of a forward line he has measured, simply by examining the numerical results of his observations, which, as recorded in the Himalaya Party, furnish checks by which no fault can pass undetected, and it is the only known method of obtaining with certainty the correct distance of an unvisited point. During the past season the surveyors having been duly cautioned not to leave a station until they had applied all the numerous checks available to the record of their angles, have carried out their work almost without having to make a single re-survey of a traverse, and this even on ground where the slopes surveyed were often so broken and steep as to be almost inaccessible, and where it was very often difficult to find sufficient space to set up the theodolite or bar. The bar-subtense method of traversing is applicable to a great variety of operations where offsets are not required from the traverse lines, and except by means of the costly and delicate subtense theodolite, there is no other practical way of obtaining the distances to unvisited points. With an error of 2½ feet per mile, the system might be largely introduced into the survey of cities, and into the difficult operations attending the survey of rivers and coasts.

Of the 83 traverses reported on, 5 were without error, 13 had an error of less than 6 inches per mile, 5 were below 2 feet per mile, and 4 were above 10 feet per mile. These errors are partly due to error in assumed length of bar and partly to the dislevelment of the theodolite, but in a city or in any ordinary ground the work could be carried on free from many of the drawbacks attending the survey of the Himalayas, and the average error of 2½ feet per mile might be considerably reduced. For this work the discs of the bars should be circular and not rhomboidal or square; the two wires of the theodolite should be at right angles to each other (one horizontal and one vertical) and not diagonal; the sight vane of the bar should be made to unship, and finally the bar itself should be made of bamboo and varnished. The discs should have a diameter of from 5 to 12 inches according to distance for which required; they should be covered with red leather, and the bar-man should be provided with white bags to slip over the discs when the aspect of the sun, the condition of the light, or the colour of the background, renders white instead of red discs desirable.

MADURA AND TRAVANCORE.

Description of the country operated in by No. 19 Party during season 1887-88, drawn up by MR. R. W. SENIOR, *Assistant Surveyor.*

A considerable portion of the country triangulated is probably about the most difficult in Southern India for survey operations, owing to the wild character of the hills therein.

Towards the north-east of Travancore lies the cardamom plateau, a mass of broken ground covered with dense forest; a few peaks, running up to 5,000 feet, stand out here and there, and with a few exceptions, they are wooded to their summits; paths are few and coolies hard to obtain, even when one is backed by official assistance. To the south of this plateau the hills roll away in a succession of smooth, grassy knolls descending gradually to the western plains and swamps of Travancore. The main highway leading from the Periyakulam taluk to Travancore runs through this portion of the year's triangulation and consists of a finely made and well-kept cart-road.

Leaving Gudalur, a village at the southern end of the Cumbum valley, the road begins to ascend the Gudalur *ghát*, winding among beautiful forest-clad hills, with an easy and steadily rising gradient; glimpses of the rich plains to the north are caught every now and

again, and clear streams, spanned by frail wooden bridges, dash along their rocky channels, offering a refreshing draught to many a weary bullock and pack animal. This route is open for cart-traffic all the year round, except, perhaps, during the heaviest portion of the monsoon.

At the summit of the *ghát*, 1,700 feet above the Cumbum plain, the air is cool and refreshing, and the traveller looks back with a feeling of relief over the dancing haze and dusty reaches of gleaming fields to the grey cliffs and lofty peaks of the Palni Hills, their bare and storm-worn summits capped with drifting mist. A new country opens before one as turning to the south one sees the grassy hills of Travancore rolling away towards the sea in gentle undulations. Animal and insect life are abundant at this altitude, while the rich green of the *sholas* and open glades is refreshing to the eye of one who has journeyed up from Periyakulam. The vast number and variety of birds that enliven these forests, when the weather is getting warm, is astonishing. All the varieties found in the Nepal and Central India jungles, supplemented by numerous gay-coated and sweet-voiced songsters quite new to a visitor, make the hills ring again with their shrill notes.

The road leads on to Kumili, a toll station of the Travancore Government with a recently opened post office. The tract of country about here, once the home of *sámbhar* and a favourite recreation ground of herds of elephants, has entirely changed its character during the past year or so. The Periyár water project has brought down engineers and their hordes of dusky coolies; dozens of grass huts have sprung up, and quite a large bazar has been started at Tekadi, 4 miles from the crest of the *ghát*.

By leaving the road a little to the west and following one of the many cooly-paths that lead to the works, hundreds of semi-nude forms of men, women and children, may be seen swarming up recently raised embankments or lazily digging, as only the Indian cooly can dig, at the bottom of deep cuttings. The Periyár project is a bold undertaking, and consists in building a gigantic concrete dam 160 feet high across the Periyár river and cutting a tunnel 2,000 yards long, through which the imprisoned water will flow into the channel of a small stream that rushes down the face of the *ghát* into the Cumbum valley. The advantages of a perpetual water-supply to a thirsty tract of thousands of acres is intended to be secured by the large expenditure of 70 lakhs of rupees.

About five miles beyond Tekadi, the Periyár river is crossed by a ferry consisting of two flat-bottomed boats connected by a staging of boards, on which three laden carts can be carried across at the same time. No charge is made for ferrying passengers or goods over, the Travancore Raja very generously keeping up the necessary establishment at his own expense. It is a pity though that a stone or suspension bridge has not been built over the stream and a trifling toll levied; the great amount of traffic carried on at almost all seasons of the year would in a very short time have paid the cost. A wooden structure was once attempted, but it succumbed to an extraordinary freshet. The Periyár, though it drains for the most part densely wooded hills, is subject to sudden and very heavy freshets, and evidence of the violence of the current on such occasions may be traced by shattered bamboo jungle and prostrate forest trees, which, torn from their holding ground by the irresistible force of the water, lie rotting on both banks of the river.

A ride of 12 miles brings one to Pirmaid, the head-quarters of a Travancore magistrate, and the most important village in these hills. From a point about 4 miles beyond Pirmaid, *viz.*, at the summer residence of the Raja, the gradual drop of the plateau to the west is distinctly appreciable, and glimpses of the low country may be had. Winding among hills and round the heads of wild rocky gorges, the road, lined on both sides with a broad belt of "Touch-me-nots," *Biophytum Sensitivum*, indigenous to the country, gradually descends by an easy gradient to Kottayam, from which town a steam-launch carries passengers to Trivandrum. Pirmaid is the centre of a coffee-planting district, and boasts of one shop where Europe goods of sorts may be purchased, and beef obtained once a week. Coffee has here, as in other parts of India and Ceylon, proved an almost total failure; tea has, however, been started with success and promises to bring about a renewal of the good old days of planting in Travancore.

The dense forests that clothe the hill ranges or lie in deep hollows (when they are termed *sholas*) contain splendid timber, and only need energetic working to convert them into a valuable source of revenue. Of the 1,277 square miles of country topographically surveyed on the 1-inch scale, the major portion consists of rugged and broken ground. The Pámbár forest reserve, area 7·72 square miles (surveyed on the 4-inch scale) through which the Kodaikánal road ascends in a series of steep zig-zags, furnishes an example of the difficulties attending large scale forest surveys in South India. Extending up the eastern face of the Kodaikánal *ghát*, an almost perpendicular cliff, this reserve embraces some of the wildest scenery of the Palni hills, with sheer precipices and dashing torrents, the difference of height between its eastern and western limits being 6,100 feet in a direct distance of 4½ miles. The Pámbár or Snake river bisects the reserve.

The Sengalvarayár forest reserve adjoins the Pámbár reserve, and was surveyed on the 1-inch scale. Like the Pámbár it extends up the face of the *ghát* and presents great difficulties of access and intricacies of feature; the difference in height of its northern and southern limits being 6,992 feet in a direct distance of 4 miles.

Of the country topographically surveyed in standard sheets Nos. 119, 149, 150, 151, 152, 182 and 183 not much can be said, the work having been confined almost entirely to forest reserves, the boundaries of which are generally drawn round moderately high and fairly accessible hills.

In the north-western corner of sheet No. 152 the hills bordering on the Warasnád valley assume a more formidable appearance and support heavy forest. In sheet No. 120, however, the greatest physical difficulties present themselves to the surveyor. Towards the eastern limit of this sheet lies the valley of Warasnád, which is bounded on the east and west by two almost parallel ranges of mountains from 4,500 to 6,600 feet high, culminating to the south in the precipitous weather-beaten peak of Kotaimalai (6,604 feet), the junction of the Madura-Tinnevelly boundary with that of Travancore; this valley consists of an endless jumble of round hills and grassy knolls sparsely covered with teak and other forest trees. These low spurs are offshoots from the higher ranges and lead up in a succession of steps to the frowning precipices that dominate the Warasnád on every side. To the west of the valley rise the Suralimalais, a lofty mass of mountains covered with impenetrable forest infested with leeches. This mass, termed in the Atlas of India "high and wavy," is more or less a plateau, and contains the sources of the Surali river, the feeders of which scarcely see the light of day till emerging from dense forest on the Cumbum side of the plateau at an elevation of 4,713 feet, the river pours itself in a sparkling cascade down the face of a black cliff over 250 feet high.

On the east of the Cumbum valley the plateau rises from the gently sloping cultivated and forest lands at its base, in a succession of bold precipices and grassy ridges to about 4,500 feet, when the hills, assuming an undulating character, rise to 6,500 feet, and comprise a series of wavy uplands covered with dense evergreen forest, impenetrable to man or beast. From Kovermalai h. s. (5,753 feet), the highest point on the northern end of the plateau, a glorious view may be obtained on fine days.

An endless succession of hill ranges with extensive plateaux and lofty peaks extends in every direction; the Cumbum valley, 4,300 feet below, with its rich fields and gardens lying wedged in between. Masses of drifting vapour hide some of the higher mountains, but as the sun dissipates the mist, new peaks and ridges spring into view; thus is the scene an ever-changing one. In the vicinity of Kotaimalai and towards the south-east edge of the Suralimalai plateau the scenery is surpassingly grand. Ridges and peaks rear their storm-torn summits proudly over the surrounding low lands, rising abruptly in many instances by a series of rocky walls, tier upon tier, to a height of 6,000 feet above sea level. It is at Kotaimalai h. s. that the wildest gorges and most disjointed geological formations occur, for here the range, forming a sort of horse-shoe, descends 5,200 feet to the level of the Tinnevelly plains in a succession of the most stupendous precipices, such as elsewhere the Himalayas alone can boast of. Fever of a most virulent type has a home among the valleys and miasmatic glades of these hills; the result of even a short sojourn here to one not perfectly acclimatised would be fatal, March to June being considered the most deadly months, during which period all but the aborigines flee the country. Of the aborigines inhabiting the more accessible of these hills, the Paliyars in British territory and the Maliyars and Mánans in Travancore may be mentioned. These people are the lords of the soil and correspond to the Todas of the Nilgiris. Coal black, with short curly hair, little sinewy limbs and of untiring endurance, they are just the men a surveyor needs in wild country, their local knowledge being of immense value among these trackless and forest-clad mountains. They affect beads round their throats and wear brass or copper rings in their ears, with very little else besides. As far as one can see, they live mostly on wild yams, which they dig up from a great depth with hard pointed sticks; nothing, however, comes amiss to them, and they eat with equal relish monkeys, lizards, putrid game, &c. Their huts are generally conical and consist of a few sticks and grass thrown on anyhow; they are, however, very clever at building huts for others. The Paliyars are incorrigible nomads, and stay in a place only so long as there are yams to be found; when these grow scarce they take their few pots and pans and seek fresh pastures.

Game of all kinds abounds, not only in the Warasnád, but all over the Travancore and Suralimalai hills. The rich, velvety grass on the low spurs affords pasture to innumerable bison and *sámbhar*, and the higher ridges and precipices teem with the South Indian ibex; pig, barking deer, mouse deer and four-horned deer lie among the thickets and tangled *sholas;* foot-prints of tigers, bears and leopards may be seen near streams or in sandy spots, and herds of elephants roam the entire country at their will. Small game too abounds; peafowl, jungle and spur fowl, quail and wood pigeons may be had almost everywhere. Monkeys of four sorts are common: the ordinary South Indian long-tailed grey monkey, which hangs about tamarind and mango topes near villages; the common baboon, the coal black baboon, and the fierce lion monkey with shaggy mane, whose deep "boom" makes the hills resound morning and evening. In March, when the weather is getting hot, snakes are met with in large numbers and of a great size; among others, the formidable *Ophiophagus Elaps* with its enormous hood and 12 feet of scaly length.

ELECTRO-TELEGRAPHIC LONGITUDE OPERATIONS.

Extract from the Narrative Report of LIEUTENANT-COLONEL G. STRAHAN, R.E., *in charge No. 23 Party (Astronomical No. 2)—season 1887-88.*

I arrived at Madras on November 15th, and as soon as the instruments reached I mounted them and had the necessary repairs executed. They had suffered considerably

en route from careless handling by the railway people, but the damages proved to be only superficial, no essential parts of either the telescopes or chronographs having been injured, and with the help of a watchmaker from Messrs. Orr and Barton, I soon had the apparatus in working order again.

Lieutenant-Colonel Heaviside joined me on November 30th, and we then proceeded to measure our personal equation on three nights, *viz.*, November 30th, December 2nd and 3rd, in the usual manner. As two years had elapsed since we had been engaged on longitude work, we thought it advisable to extend the measurement over three nights instead of two only (the usual number), and, considering the first night as practice only, to reject from the final personal equation the results of that night.

The arcs assigned for measurement during the season were as follows:—

1. Madras,	Colonel	Strahan.	Bangalore,	Colonel	Heaviside.
2. Bangalore,	„	Heaviside.	Nagarkoil,	„	Strahan.
3. Madras,	„	„	„	„	„
4. Nagarkoil	„	Strahan.	Mangalore	„	Heaviside.
5. Madras,	„	„	„	„	„
6. Bellary,	„	„	„	„	„
7. Mangalore,	„	Heaviside.	Bombay,	„	Strahan.

Of these arcs, the first, Madras-Bangalore, and fifth, Madras-Mangalore, had been previously measured in season 1872-73, but had been rejected by General Walker, then Superintendent of the Great Trigonometrical Survey, for reasons stated in his report of that year. The seventh, Mangalore-Bombay, had been partly measured, *i.e.*, only three nights' observations had been taken instead of the normal number of six. Nagarkoil was selected for a longitude station as being the nearest point to Cape Comorin, at which a telegraph line was available. This was the only station this season which required any triangulation to connect it with the main network of principal triangulation, all the others having been previously used and connected as usual.

I may mention here that the triangulation for connecting Nagarkoil was executed by Mr. Bond, whose services were temporarily placed at my disposal for this purpose, as there were no sub-surveyors attached to either of the Astronomical Parties who were competent to carry it out satisfactorily. It entailed a good deal of very rough climbing, and gave Mr. Bond full employment for 9 weeks. The computed results afford satisfactory tests of the correctness of Mr. Bond's work.

The measurement of the first arc, Madras-Bangalore, was delayed by constant interruptions from rain and cloud, and once by the malicious cutting of the temporary telegraph wire at Bangalore. It was commenced on December 13th and not completed until January 2nd. The north-east monsoon was abnormally heavy in Madras, and night after night no observations were possible owing to the intervention of thick clouds.

The second arc, Bangalore-Nagarkoil, was commenced on January 15th and completed on January 20th. At the latter station the weather was uniformly favourable throughout the whole of my stay. It is a somewhat difficult place to get at, the nearest railway station being at Palamcottah, over 40 miles distant. The road is however a good one, and the instruments sustained no damage of any kind from their conveyance in countrycarts.

After the measurement of the second arc, Bangalore-Nagarkoil, Colonel Heaviside visited me with the object of determining again our relative personal equation. It has always been usual to measure this three times during the season, a custom which was not departed from this year, measurements having been made at Madras at the commencement of the season, at Nagarkoil about the middle, and at Bombay at the end of it. The results are as follows:—

	At Madras.	At Nagarkoil.	At Bombay.
	s	s	s
For N. stars	S−H=+·009	−·047	−·046
S. „	S−H=+·036	−·010	−·009

where the initials S and H stand for Colonels Strahan and Heaviside respectively.

The third arc, Madras-Nagarkoil, was measured between February 2nd and 7th; the fourth arc, Nagarkoil-Mangalore, between February 18th and 24th; the fifth, Madras-Mangalore, between March 5th and 12th; the sixth, Bellary-Mangalore, between March 21st and 27th, and the 7th and last, Mangalore-Bombay, between April 4th and 8th. The transit telescopes and camp equipment were then stored in Colaba, and the chronographs brought with me to recess quarters for experiments with the Russian transits at Mussooree in compliance with orders received.

In addition to the ordinary longitude work, I took the opportunity at Nagarkoil, whilst waiting for my colleague to move from Bangalore to Madras and again from Madras to Mangalore, to make some experiments on the stability of No. 2 telescope, with a view to throwing some further light on the mysterious daily differences which have so frequently been noticed in previous reports. The experiments were of two kinds, and were directed with a view to ascertain if the time of transit of a star, after all corrections were applied, varied with the position of the telescope, *i.e.*, I. P. E. or I. P. W., or with its elevation. In the first set I selected an equal number of stars north and south of the zenith, and contrived to observe their transits over the first half of the wires by direct observation, and over the last half by reflection from mercury. The observations then being all reduced to the centre wire, it becomes easy to see if any irregularity is produced by an alteration in the elevation of the telescope. To avoid any bias in observing, the direct observation

preceded and succeeded the reflected one with alternate stars. It is somewhat difficult with stars near the equator to secure both observations, but I introduced a simple contrivance for placing the mercury trough which considerably facilitated matters. This consists of a stout plank placed on the ground with its length in the direction of the meridian, either due south or north of the transit telescope according as south or north stars were to be observed. The mercury trough was laid on a sort of a little truck on wheels which could be pushed along the plank. On the plank were painted strong lines showing the position at which the truck should be placed for the different degrees of altitude of stars observed. My observatory assistant, after calling out to me the altitude of the star for observation, moved the truck to its proper place on the plank, while I was setting the finding circle of the transit, and I thus could rely on having my mercury at once in the correct place for securing the reflected observation. The disturbance of the surface of the mercury by light currents of air proved the chief difficulty, which was only partly obviated by arranging curtains round the trough. These observations are satisfactory, inasmuch as they show that an alteration of the elevation of the telescope does not affect the time of transit appreciably. The result of the two nights' work is given in the following table:—

	B. A. C. No. of Star.	Direct minus Reflected.		B. A. C. No. of Star.	Direct minus Reflected.
		s.			s.
North Stars.	1,541	—·07	North Stars.	1,541	—·17
	1,558	—·12		1,602	—·02
	1,602	+·04		1,663	—·10
	1,690	+·04		1,723	—·12
	1,742	—·18		1,768	—·18
	1,449	—·03		1,520	—·04
	1,468	—·03		1,558	+·06
	1,463	—·13		1,631	—·14
	1,723	—·03		1,690	—·05
	1,792	—·16		1,742	—·04
	Mean for North Stars.	—·07		Mean for North Stars.	—·08
South Stars.	2,034	—·11	South Stars.	1,843	—·22
	2,061	—·16		1,901	—·14
	2,171	—·16		1,959	—·19
	2,222	—·16		2,034	—·21
	2,246	+·12		2,088	—·19
	1,941	+·07		1,871	—·12
	2,088	+·08		1,941	—·01
	2,112	+·06		1,997	—·03
	2,267	+·02		2,061	—·06
				2,111	—·09
	Mean for South Stars.	—·02		Mean for South Stars.	—·13

The second set of observations was precisely similar to that carried out in Burma in 1883, and was as follows:—On the first of three nights two groups of stars, containing 8 each, were observed I. P. E., and subsequently two more I. P. W.; on the second night the first group was observed I. P. W., the second and third I. P. E. and the fourth I. P. W.; and on the third night the first and second groups were observed I. P. W., and the third and fourth I. P. E. We are thus enabled to see by means of examining the clock rates from night to night what change (if any) is caused by the reversal of pivots. This is shown in the following synopsis:—

	February 9th.	Clock rate correction, 9th to 10th.	February 10th.	Clock rate correction, 10th to 11th.	February 11th.
		s.		s.	
1st group . . .	I. P. E.	+·518	I. P. W.	+·709	I. P. W.
2nd „ . . .	„ E.	+·649	„ E.	+·568	„ W.
3rd „ . . .	„ W.	+·681	„ E.	+·681	„ E.
4th „ . . .	„ W.	+·586	„ W.	+·747	„ E.

The discrepancy of the clock rate corrections in the 3rd column are due to some displacement of the telescope, supposing the rate to be depended on as constant during the time of observation, and the same remark holds with regard to the 5th column. The discrepancy is not large, but it is certainly appreciable, and is no doubt caused by the same flexure, or fault of some kind, to which the daily differences are due. It is worthy of notice that for both dates the change of pivot from E. to W. gives the smallest rate, and from W. to E. the largest, from which one would suppose *á priori* that either

the telescope when I. P. E. describes a circle west of the true meridian, or when I. P. W. a circle east of it, or more likely still, the discrepant clock rate is due to both these causes combined. The numbers in the 3rd and 5th columns may be used to ascertain the most probable values of the deviations from the meridian, although they give no clue whatever to their causes.

Thus suppose r to be true value of clock rate between February 9th and 10th and r' between 10th and 11th, and let y_e and y_w be the corrections to be added to the times of transit in positions I. P. E. and I. P. W. respectively, due to flexure or other unknown cause. Then we can form the following equations from the foregoing table :—

(1) $r + y_e - y_w = +\cdot518$	(5) $r' + y_w - y_w = +\cdot709$
(2) $r + y_e - y_e = +\cdot649$	(6) $r' + y_e - y_w = +\cdot568$
(3) $r + y_w - y_e = +\cdot681$	(7) $r' + y_e - y_e = +\cdot681$
(4) $r + y_w - y_w = +\cdot586$	(8) $r' + y_w - y_e = +\cdot747$

Substitute in (1), (3), (5), and (7) the values of r obtained from (2), (4), (6), (8), respectively and we get—

$$y_e - y_w = -\cdot131 \qquad y_e - y_w = -\cdot141$$
$$y_e - y_w = -\cdot095 \qquad y_e - y_w = -\cdot066$$
$$\text{whence } y_e - y_w = -\cdot108$$

from which equation we must, in the absence of further evidence, assume that $y_e = -\cdot054$, $y_w = +\cdot054$, which numbers do not disagree violently from those found at page (41) of the appendix to the Professional Volume X, obtained by somewhat similar methods in previous years. It has been supposed above that the corrections y_e, y_w are independent of declination, and are the same for all stars—a supposition which, though of course not true, is justifiable in a discussion of this kind involving a considerable number of stars of varying declinations.

With the help of three extra computers the usual computations were completed by the third week in June, in addition to some others in connection with experiments made with the Russian transit instruments, which experiments were ordered to be undertaken with a view of ascertaining whether these instruments were sufficiently trustworthy to be used in the longitude operations. The experiments being of a simple nature, I will give an account of them here before proceeding to the discussion in detail of the arcs measured during the field season.

The object being to ascertain if the two Russian transits could with advantage be employed instead of the large and heavy transits now in use, in the hope that they might prove to be free from the small systematic errors to which the latter instruments are liable, it was deemed advisable to measure an experimental arc at Mussooree—both instruments being on the same meridian (or so nearly so that the distance between them might be neglected). The same clock was employed to graduate both chronographs, and the same stars (about 20 in number) were observed with both transits, the observers changing places after the first half of the programme had been finished, in order to avoid any correction for, or uncertainty about, personal equation.

The results of two nights' observations showed that though fairly good work might be obtained with No. 1 transit, No. 2 is in its present state untrustworthy, for three reasons —1st, the object glass is very inferior and gives a large blurred image of a star ; 2nd, the level is unstable and the bubble unsuitable, not having been designed for the instrument ; and 3rd, the illumination is defective. An examination of clock error, as deduced from Nautical Almanac Stars, showed that No. 1 is not much inferior to the large transits now in use, and there is a reasonable hope that when No. 2 is made equal to it, they might be employed in the electro-telegraphic longitude work, at all events for one season on trial.

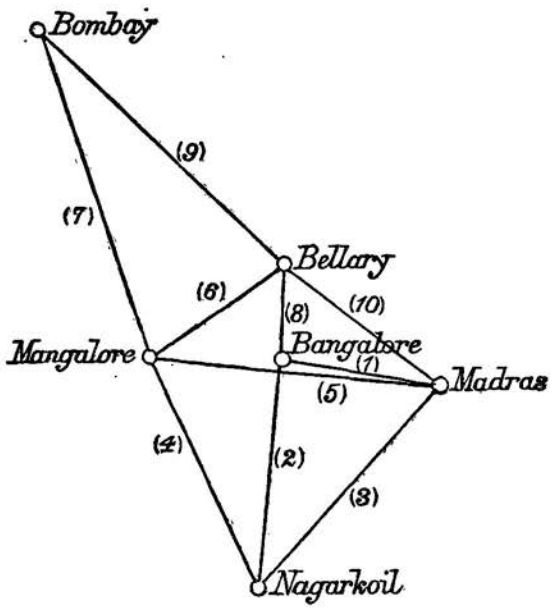
With regard to the arcs measured during the season under review, I am glad to be able to report that the circuit errors are much diminished in comparison with those of some previous years. The same very close agreement of the results during each night's work still holds, and the daily differences, though still obvious, are less than heretofore ; indeed in arcs Nos. 2, 3, 6 they have nearly vanished. The close accordance also between the new and old values of the arc, Mangalore-Bombay, is satisfactory. For convenience of reference I give here the results in a tabular form, showing also the corresponding geodetic arcs and the difference between the electro-telegraphic and geodetic values, as well as the circuit errors, in which some previously measured arcs are necessarily mixed up :—

	Electro-Telegraphic arc.	Geodetic arc.	Geodetic arc minus Telegraphic arc.
	m. *s.*	*m.* *s.*	*s.*
(1) Madras-Bangalore	10 39·324	10 39·609	+0·285
(2) Bangalore-Nagarkoil	0 35·615	0 35·776	0·161
(3) Madras-Nagarkoil	11 14·875	11 15·385	0·510
(4) Nagarkoil-Mangalore	10 21·193	10 21 390	0·197
(5) Madras-Mangalore	21 36·142	21 36·775	0·633
(6) Bellary-Mangalore	8 19·666	8 19·792	0·126
(7) Mangalore-Bombay	8 7·392	8 7·574	0 182
(8) Bangalore-Bellary	2 37·392	2 37 374	0·012
(9) Bellary-Bombay	16 26·957	16 27·366	0·409
(10) Madras-Bellary	13 16·564	13 16·98	0·419

Of these arcs the first six are entirely new, the seventh is partly new and partly old, the former value being 8m. 7·415s., and the latter 8m. 7·369s., and the last three are old.

The circuit errors deduced from the above are—

(1) + (2) − (3) = + ·064
(3) + (4) − (5) = − ·074
(1) + (8) − (10) = + ·122
(10) + (6) − (5) = + ·088
(6) + (7) − (9) = + ·101



(3) + (4) + (7) − (9) − (10) = − ·061
(3) + (4) − (6) − (10) = − ·162
(3) − (2) + (8) − (10) = + ·058
(5) + (7) − (9) − (10) = + ·013
(2) + (4) + (7) − (8) − (9) = − ·119
(2) + (4) − (6) − (8) = + ·180

These circuit errors are considerably more satisfactory than in the two previous years, and are perhaps as small as can reasonably be expected. I have made a preliminary adjustment of the figure in order to show what sort of magnitude the corrections eventually to be applied to these arcs are likely to attain to. The process is very simple, the arcs being all considered of equal weight. Let x_1, x_2, x_3, &c., be the corrections to arc (1), (2), (3), &c., then (since it is obvious that if the triangular circuits are made free from error, the circuits in the 2nd group of equations above will also be errorless, and also that any of the 2nd group may be obtained by addition and subtraction from the 1st group) we have the following equations to be solved with the condition that the sum of the squares of the corrections should be a minimum, *viz.* :—

$$x_1 + x_2 - x_3 = -\cdot064$$
$$x_3 + x_4 - x_5 = +\cdot074$$
$$x_1 + x_8 - x_{10} = +\cdot122$$
$$x_{10} + x_6 - x_5 = +\cdot088$$
$$x_6 + x_7 - x_9 = +\cdot101$$

It is unnecessary to give here in detail the solution of the equations; the values satisfying the proposed condition are as follows:—

	s.		s.
x_1	= + ·050	x_6	= + ·078
x_2	= − ·020	x_7	= + ·012
x_3	= − ·034	x_8	= + ·069
x_4	= − ·053	x_9	= − ·011
x_5	= − ·013	x_{10}	= − ·003

The largest of these corrections corresponds to about 160 feet in linear measure; the mean is about 70 feet.

The next table gives the values of the corrected arcs and the comparison with the geodetic values:—

	Electro-Telegraphic arcs.		Geodetic arcs.		Telegraphic minus Geodetic arcs.
	m.	s.	m.	s.	s
(1)	10	39·274	10	39·609	+ 0·335
(2)	0	35·635	0	35·776	+ 0·141
(3)	11	14·909	11	15·385	+ 0·476
(4)	10	21·246	10	21·390	+ 0·144
(5)	21	36·155	21	36·775	+ 0·620
(6)	8	19·588	8	19·792	+ 0·204
(7)	8	7·380	8	7·574	+ 0·194
(8)	2	37·293	2	37·374	+ 0·081
(9)	16	26·968	16	27·366	+ 0·397
(10)	13	16·567	13	16·983	+ 0·416

It is remarkable that in every case in the figure under consideration, the geodetic arc is larger than the telegraphic, more especially so in the cases of those arcs that lie east and west and have one or both of their terminal stations on the sea coast.

This tends strongly to confirm the evidence already collected that there is a perceptible attraction of the plumb line towards the ocean. We can deduce from the above figures an approximate value of this deviation of the plumb line. As the number of unknown quantities (*viz.*, the deviations) exceed the number of equations, I introduce the condition that the sum of the squares of the deviations shall be a minimum, and then find their values to be as follows :—

		Secs. of time.	Secs of arc.
At Madras,	eastward.	·444	6·66
„ Bangalore	„	·108	1·62
„ Bellary	„	·027	0·41
„ Bombay,	westward	·370	5·55
„ Nagarkoil	„	·033	0·50
„ Mangalore	„	·176	2·64

These numbers are only preliminary, nothing final can advantageously be deduced from the longitude arcs until the whole scheme is worked out, and a connection made with Kalianpur, the origin of Indian longitudes, but they are interesting as confirming the evidence already obtained by swinging pendulums and by levelling, of the increase of density in the sub-marine strata.

TIDAL OPERATIONS.

Extract from the Narrative Report of MAJOR M. W. ROGERS, R.E., *in charge No. 25 Party—Season 1887-88.*

I shall now briefly describe the working of each observatory during the year under report, commencing at Aden and following the coast to Burma.

Aden.—The self-registering tide gauge has worked very satisfactorily during the last twelve months ; there have been six short unimportant breaks of a few hours each, owing to the stopping of the clock, or the pencil having failed to mark.

The self-registering aneroids by Adie and Légé have worked continuously throughout the year.

The self-registering anemometer had to be cleaned last November, since which time its records were satisfactory until 28th July, when it got out of order and had to be repaired.

The Aden tidal observatory has not been inspected during the year ; the last inspection was made by Major Hill in August 1886. I hope to arrange to inspect it this year, but the time and expense involved are great and cannot often be spared. It would be a great saving of both if, when any duly qualified officer of the Department was returning from or going to England, his services could be utilised to perform this inspection.

Kurrachee.—The self-registering tide gauge at this station has worked satisfactorily during the year under report ; there have been some unimportant breaks for a few hours at a time, but none worthy of special notice or that in any way damaged the observations. The clock was cleaned and repaired twice by the mechanic attached to the Harbour Works.

The self-registering aneroid has also been registering in a very satisfactory manner.

The self-registering anemometer has worked continuously with the exception of two days in February, when it was cleaned and repaired by the local mechanic.

There has been no inspection of this observatory during the year under report for the reasons mentioned in Major Hill's report for last year ; all the arrangements and repairs are so well looked after by Mr. Price, the Port Engineer, that frequent inspections are unnecessary.

Bhávnagar.—The registrations of the self-registering tide gauge at this station have been very satisfactory throughout the year. There was a fortnightly interruption of about three hours (necessitated by the flushing out of the cylinder), but in addition to this the accidental stoppages were few and unimportant. The wire at the float end of the gauge got entangled and out of gear on one occasion in January, but it was quickly remedied, and zero measurements were taken at once by the Assistant Engineer.

The self-registering aneroid has worked continuously and satisfactorily during the year without a single recorded stoppage.

The self-registering anemometer has also been working in a very satisfactory manner, only two or three unimportant stoppages having occurred.

The observatory was inspected by Major Hill, accompanied by Sub-Surveyor Dhondu Venayek and the native mechanic in December 1887 ; during this inspection he discovered that the float band had been broken and repaired and the circumstance not reported by the clerk : this breakage was detected by the discrepancy in the zero measurements. The date of the break was ascertained and the necessary corrections to the zero made. Major Hill also put down and connected another bench-mark of reference.

This observatory is well looked after by Mr. Proctor Sims, the State Engineer, and his assistants, who take great interest in the work, and to whom our best thanks are due.

The Bhávnagar State has asked us to procure another tide gauge for erection at Káthiáwádar Bunder, and having regard to the number belonging to the Survey Department

which will be without work in a short time, I think that should the State Engineer wish it, one could be supplied on loan.

Bombay.—The record of the self-registering tide gauge at this station has been satisfactory during the year and there have been no breaks; the graduated staff has been several times under repair, but nothing else has been in any way damaged.

There is neither aneroid barometer nor anemometer in this observatory.

The observatory was inspected by Major Hill, accompanied by Sub-Surveyor Dhondu Venayek and the native mechanic, when the instrument and clock were taken to pieces and thoroughly cleaned and re-started in perfect order.

Some years ago the Port Trust obtained a tide gauge from Messrs. Légé & Co. of a different pattern to those used in the Tidal work. The cylinder is upright and two feet long. The paper for the Tidal diagram is one long continuous roll—sufficient for over a year's record—on a vertical spindle and about two feet wide. There are two auxiliary cylinders, one on each side of the main cylinder. The paper passes automatically from the roll, over one of the auxiliary cylinders, then almost entirely round the main cylinder, and is finally wound round the other auxiliary cylinder. The recording pencil in connection with the mechanism of the gauge presses against the paper as it passes over the main cylinder. The paper is quite plain and has no hour or height lines, but the former are marked on it at each edge by small pin holes which are pierced in it as it passes over the recording cylinder. The float band is not continuous as in the old gauges, but is wound up on a wheel by the action of a weight as the tide rises and unwinds again as the tide falls. The gauge has been erected in the light-house tower between the entrances to the Prince's dock—a space for the float cylinder and a connection with the sea having been arranged for in building the dock.

The gauge has been placed on the first floor of the light-house, where the light is displayed, the ground floor being unsuited, as it contains the dynamo for the electric light, whose proximity would have affected the clock. The cylinder in which the float works has its top about 18 inches above the ground floor and is 21 feet below the bed-plate; the band works in a wooden box which fits on the wooden top of the cylinder, and is thus perfectly protected.

The gauge band, clock, &c., on the floor above are protected by a wooden cupboard with glass doors.

Certain modifications as to the reading and recording of the diagrams will have to be made in this instrument, from whose record we shall probably be called upon to prepare Tide Tables for the dock entrance, where the times of the tide differ considerably from those at the Apollo Bunder.

The zero of the new gauge has been made to correspond with that of the Bombay Tide Tables, and it was started on the 22nd September.

Mormugáo.—The self-registering tide gauge has been working satisfactorily during the year; there have been six failures of the record of a few hours duration only—one caused by the stoppage of the driving clock, and the remainder from the pencil failing to mark on the diagram; the band also broke on the 18th June and was not repaired until the 20th, whereby about 36 hours' registrations were lost; but this can be remedied by interpolation.

The self-registering aneroid by Adie has not been working satisfactorily during the year, so it was removed by Major Hill at his inspection in April 1888, and the instrument by Légé, which has also been working at this station, was left in its place. The instrument by Adie had been working in the Palace, about 35 feet above the level of the sea, whilst Légé's aneroid had been placed in the bungalow of the Executive Engineer, Mr. Good, which is some 150 feet above the sea; it was removed from thence to the Port Office on the quay after Mr. Good's departure and has now been placed by Major Hill in the verandah of the palace where Adie's barometer used to stand.

The anemometer has not been working satisfactorily during the year, and was removed to Poona for repair by Major Hill in April 1888. The register will be obtained during its absence from the instrument belonging to the Western India Portuguese Railway.

The observatory was inspected in April 1888 by Major Hill, accompanied by Mr. Eccles and Sub-Surveyor Dhondu Venayek.

The bench-mark of reference was found to have sunk 0·146 of a foot owing to the railway platform on which it stood having been built up to a height of 5 feet above it: this subsidence was tested by reference to a second bench-mark whose level was found unaltered.

Cochin.—The self-registering tide gauge at this port has been working very satisfactorily during the past year; there is only one stoppage of a few hours recorded in that time; the tides at this place are liable to sharp rises and falls produced by squalls: two of these, in which the tide fell nearly a foot very rapidly, were recorded on the 11th May and 19th June.

The anemometer failed to work on twelve occasions between October and May, causing a break of from one to eight hours on each occasion; since the 12th May, however, it has been working most satisfactorily without any interruption.

The self-registering aneroid has not worked well this year, and since the 9th of February the clock has been entirely out of order, and readings have been taken only at 7 A.M., 10 A.M., 4 P.M. and 6 P.M., at the same time as those of the mercurial barometer.

The observatory was inspected in February 1888 by Major Hill, when all the instruments were cleaned. Captain Winckler, the Port Officer, continues to take great interest in the registrations and to do all in his power to further them.

Colombo.—The self-registering tide gauge has been working satisfactorily at this station, the observations being continuous with the exception of a few breaks of an hour or two each.

The observatory was inspected in January 1888 by Major Hill, accompanied by Sub-Surveyor Dhondu Venayek and the mechanic of the party, when all the instruments were cleaned and put in thorough working order.

There is no anemometer or barometer at this station; the readings were supplied from the office of the Surveyor-General of Ceylon.

Captain Donnan, the Master Attendant, has supervised the registrations as before, and thanks are due to him for his kindness.

Galle.—The self-registering tide gauge has worked satisfactorily at this station; only a few unimportant breaks have occurred, due chiefly to the pencil failing to mark.

The anemometer registrations have also been most satisfactory, only one stoppage having been recorded.

The self-registering aneroid by Légé and Co. has worked continuously throughout the year; that by Adie, although it worked, failed to register the diurnal curves correctly from October until January, when it was repaired and registered correctly until the 21st July, when it appeared to be marking $\frac{1}{10}$th less than the dial reading. Major Hill, with Sub-Surveyor Dhondu Venayek and the mechanic, inspected this observatory in January 1888 and cleaned and put in order all the instruments.

Captain Blyth, the Master Attendant, has continued to supervise the registrations, and thanks are due to him for the interest he takes in their success.

Tuticorin.—The site for this observatory was selected by Major Hill in December 1887, when on his tour of inspection, and he then made arrangements with the Madras Government and the Port Authorities for the construction of an observatory to contain the instruments.

It is situated at the north re-entering angle of the T head of the Government jetty; it is well and strongly constructed on stout piles and isolated from the jetty, and also protected by external piles braced together, making it safe from the impact of boats.

The float cylinder is 8 feet in length, 2 feet internal diameter, and painted white inside and outside to prevent rust. The bottom of the cylinder is 2 feet above the ground below, and it is calculated that there will be at least 1 foot of water in the cylinder at low water spring tides.

The cylinder is closed at the bottom with a $\frac{1}{4}$th inch plate of iron attached by means of bolts and nuts to its flange. This plate has $5\frac{1}{2}$ inch perforations for the inlet and outlet of the water.

The self-registering anemometer is fixed on a bracket under the ridge of the eastern gable of the observatory.

The self-registering aneroid by Adie is erected on a shelf in the observatory and the mercurial barometer is fixed against the wall.

All these instruments were in use at Negapatam and were brought direct from there by Mr. Belcham, on the conclusion of the observations at that port.

A graduated staff, 5 feet in length, for checking the level of the water in the cylinder, has been attached to the centre pile on the west side of the observatory, its zero corresponding with that of the gauge.

The observatory was constructed by Mr. Russell, the Executive Engineer, Tuticorin, from plans supplied to him by Major Hill, and is a very neat and creditable piece of work.

The instruments were removed from Negapatam on the 30th April by Mr. Belcham and taken by him to Tuticorin. The observatory, however, was not ready for occupation until the 26th May, when the tide gauge was set up and observations finally started on the 1st June 1888, and they have been proceeding satisfactorily since that date.

The bed-plate of the gauge has been connected by levelling with two bench-marks of reference, those chosen being bench-marks Nos. 46 and 47 in Section Ramnad to Tuticorin of Spirit-levelled Heights No. 2, Madras Presidency, Season 1885-86.

Captain Phipps, the Port Officer, takes much interest in the observations, and has kindly consented to superintend them; the clerk also is an experienced man, having been transferred with the instruments from Negapatam.

Negapatam.—The self-registering tide gauge at this station has been working satisfactorily up to the date of the conclusion of the observations, there having been only a few interruptions for an hour or two at a time, owing chiefly to the sticking of the pencil.

The self-registering aneroid also worked well during the period under report.

The self-registering anemometer worked, without stoppage, until the end of the observations.

The observatory was inspected in January 1888 by Major Hill, accompanied by Sub-Surveyor Dhondu Venayek and the native mechanic, when all the instruments were thoroughly cleaned and set in working order.

Observations at Negapatam were commenced in November 1881 and were carried on until November 1884; however, the observations for the year 1883-84 had to be rejected owing to the retardation caused by an accumulation of sand around the float cylinder in the back-water where the observatory is situated. This retardation was felt more or less during the next 15 months, and the observations during that time were unreliable; however, in 1885 the natural conditions which had caused the sand to accumulate seem to have been changed and the cylinder was again left free, and was with much care and

trouble kept so during the rest of the observations, the final three years of which were terminated in March 1888; the years for which the observations have been accepted are 1881-82, 1882-83, 1885-86, 1886-87, 1887-88.

The observatory was finally dismantled by Mr. Belcham on the 30th April 1888 and all the instruments removed to Tuticorin.

There have been several Port Officers at Negapatam during the continuance of the observations; they have all been most helpful to us, and we owe a great deal to their kindness in supervising the observations and doing their best to obviate the many difficulties which occurred at this port.

Madras.—The self-registering tide gauge has been working satisfactorily, and the interruptions in the registration have been unimportant. The observatory was inspected in December 1887 by Major Hill, who put on a new float band and substituted a chain for the old pencil wire; he also cleaned all the instruments and put them into working order.

There is no anemometer at this port.

The aneroid has not been working satisfactorily; there have been constant stoppages of the clock since April, and it has been twice sent to Messrs. Orr & Co. for repair, and several long breaks have occurred in the registrations.

Cocanada.—The self-registering tide gauge at this port has worked without a stoppage during the last year; it has therefore been working for 2½ years without any break —a circumstance almost unparalleled in the record of the work.

The self-registering aneroid has also recorded without any break; but it is not a satisfactory instrument, and will be changed at the next inspection for one of a newer pattern by Légé.

The mercurial barometer was out of order for 8 days, during which time the readings were supplied by the Meteorological Department.

The self-registering anemometer has worked well, there having been but three unimportant stoppages.

The observatory was inspected in February 1888 by Major Hill, when all the instruments were left in good order and working satisfactorily except the aneroid.

Captain Baker, the Port Officer, has continued his kind supervision of the work during the past year.

Kidderpore.—The registrations of the tide gauge have been very satisfactory throughout the year, only four breaks of a few hours having occurred, owing to the stoppage of the driving clock.

The self-registering aneroid worked well during the year until August, when the marking of the pencil on the diagrams was found defective; it was repaired by the Mathematical Instrument Maker at Calcutta, and has since been working satisfactorily.

There have been a few stoppages of the self-registering anemometer owing to the failure of the driving clock, but, on the whole, the registrations have been satisfactory.

The observatory was inspected in February 1888 by Mr. Belcham, accompanied by the native mechanic, at which time all the instruments were cleaned and set in order.

It will be necessary, early next year, to remove the observatory from its present site, which is required for the new Calcutta docks; it will be placed about 10 chains lower down the river until the new dock is complete, when it will receive a permanent location.

I have much pleasure in acknowledging the kind interest which Lieutenant Petley, R.N., continues to take in the observations which are under his immediate supervision.

Chittagong.—The self-registering tide gauge has been working very well during the year under report, there having been no recorded stoppages.

The self-registering aneroid has worked very fairly for the first half of the year, but since May it has not registered the diurnal inequality correctly, and it will be necessary to thoroughly overhaul it at the next inspection, and, if required, substitute another instrument.

The self-registering anemometer has registered satisfactorily during the year; its fans were maliciously injured by some person in November last, but were repaired at once by local help.

Mr. Good, the Port Officer, has continued to supervise the registrations, and my best thanks are due to him for his kindness.

Akyab.—The work of the self-registering tide gauge at this station has been good, although there have been several short breaks of a few hours owing to the stoppage of the clock.

The self-registering anemometer has been working very satisfactorily during the past year, only two breaks of registration of a few hours each having been recorded.

The self-registering aneroid has not given satisfactory results for the first six months of the year; in November last the minute-hand of the driving clock ceased to revolve, having become loose on its spindle, and therefore the marker ceased to act; the clerk instead of reporting the matter to the Port Officer, used to revolve the hand himself, whenever he came to the observatory, thereby obtaining the record at such times on the diagram, which he then filled in according to his own fancy. This was not detected until the observatory was inspected, when the clock was repaired and re-started.

The observatory was inspected by Mr. Belcham in April 1888, when all the instruments were cleaned and put into working order, and the mercurial barometer belonging to the observatory put up in the place of the one which had been lent by the Port Officer.

My best thanks are due to Captain Fenn for the interest he has taken in the observations.

Elephant Point.—The self-registering tide gauge at this place has worked satisfactorily, there having been only one break of any length, and two days during which the float was sent to Rangoon for repairs.

On the 21st of November last a violent shock of earthquake was experienced which stopped the clock, and the same accident happened several times from storms and the strength of the current in the river.

The self-registering aneroid has not worked satisfactorily, there having been frequent stoppages; and on the 2nd November 1887 the chain connecting the spring and pencil broke and the instrument had to be sent to Rangoon for repairs, and had not been returned at the time of the inspection by Mr. Belcham in March last. It was then repaired by the mechanic of the party, and has since worked satisfactorily.

The self-registering anemometer has worked very well, there being only one recorded stoppage.

This observatory has for some time been in a shaky condition, and various devices have been had recourse to in order to strengthen it and its bridge of communication with the bank. Finally, on the 18th June last, there was a heavy storm, which rendered the structure so unsafe that the clerk removed the gauge, and when the Port Engineer from Rangoon inspected it he decided that it was not possible to render it safe, especially as the monsoon was shortly expected; and he reported that if the observations were to be continued, a new observatory would have to be built. As 4½ years' observations had been completed, I did not consider that it was expedient to incur the expense of building a new observatory to complete one more year's observations, so I instructed the Port authorities to dismantle the observatory and remove the tide gauge to Rangoon, and also the self-registering aneroid and anemometer which were working at the Telegraph office.

Elephant Point has been a station which has always given trouble owing to the force of the river current and the nature of the banks, which were in a constant state of erosion. The first observatory erected there had to be abandoned, and the instruments removed after 10 months work had been completed, and I consider that we are very fortunate in having obtained 4½ years' continuous registrations at the new site.

Rangoon.—There have been many interruptions to the tidal registrations during the last year, although none of them have lasted for any great length of time; the clock of the tide gauge stopped on eleven occasions, due presumably to the great vibration of the wharf when there is heavy traffic, and in addition the float band became entangled three times and slipped off the stud wheel on five occasions; these last accidents are, no doubt, due to the immense quantity of paddy husks which float on the surface of the river and stick to the band: an arrangement of brushes whereby the band is cleaned as it rises was devised at the last inspection, and will, it is hoped, remedy this evil.

On the 1st February the wire at the float end broke, but the clerk was present and a new one was immediately substituted, and as the inspection took place shortly afterwards, no harm was done. In January an iron cylinder for the float was substituted for the wooden float box which had been used previously and which was always getting out of repair. This and the erection of a graduated staff, the absence of which was noticed by Major Hill in his last year's report, are two permanent improvements effected in this observatory during the year under report.

The self-registering aneroid barometer has not been working well; the clock has been constantly stopping, the stoppages being chiefly due to vibration and concussion on the wharf; it has been twice in the hands of the local watchmaker for 12 and 8 days respectively, and has also been repaired by the native mechanic at the inspection; however, since the last repairs in May 1888, the registrations have been more continuous.

The self registering anemometer has been working in a fairly satisfactory manner during the past year; it was cleaned and repaired by the native mechanic at the inspection of February 1888, previous to which there had been numerous stoppages for short periods, but since then it has worked continuously.

My best thanks are due to Mr. Darlington, the Chairman of the Port Commissioners, and to Mr. Reichenbach, the Port Engineer, for the great help that they have rendered to us, both at Rangoon and Elephant Point.

Port Blair.—The registrations of the self-registering tide gauge have been nearly continuous during the year; but up to February, the date of the last inspection, there has been retardation owing to the holes in the cylinder for the ingress and egress of the water being pierced too low; this was remedied, and since then the fault has disappeared.

The self-registering aneroid barometer and the anemometer have both worked very well during the last year, there having been no recorded stoppages.

The observatory was inspected in February 1888 by Mr. Belcham, who was accompanied by the mechanic of the party.

Taken as a whole the work of the Tidal observatories has been very satisfactory during the past year, and, with the exception of the forced discontinuance of the Elephant Point observatory, there has been nothing wrong.

Reduction of the Tidal observations.—During the year under report the amount of work done has been greater than in any previous year. The observations at 16 stations have been reduced: in the case of one of these, three years' computations were completed, and of another, two years; so the total outturn has been equivalent to one year's reductions

of 19 stations. The tabulated values of the tidal constants so obtained are appended. The discussion of the yearly results has been discontinued, as it was decided by Major Hill and myself that these discussions, although they had been valuable and interesting in the early years of the work, when the harmonic analysis was, so to speak, on its trial, are not now of sufficient value to compensate for the labour of producing them, and it is in every way better to defer the discussion until the observations at any station are closed, when they can be presented in a tabular form and discussed as a whole.

A commencement has been made this year in the reduction of the meteorological records of the observatories. At present the computations are entirely tentative, as the best method of their reduction and the application of their results to the tides has yet to be determined. Three years' observations at Kárwár have been selected, and the preliminary reductions and corrections have been taken in hand.

A table showing the present state of the ordinary tidal computations is appended, together with their state at the date of the last report. The letters A. P. in the table indicate that the actual times and heights of high and low water for 1887 were measured in duplicate from the tidal diagrams and compared with the predicted values contained in the Tide Tables for that year. Thus the actual amount of work done during the year under report can be seen.

There has been in addition a good deal of extra tidal work; several statements and returns have been supplied to the Marine Survey of India, and reports on the Bombay and Burma tidal observations have been prepared for the Local Governments.

State of the ordinary reductions of the yearly tidal registrations at the beginning and end of the Survey year 1887-88.

Tidal observatory.	State at end of September 1887.	State at end of September.
ADEN . . .	1885-86. Calculations completed. 1886-87. Diagrams not read off. A. P.	1886-87. Calculations completed. 1887-88. Diagrams not read off. A. P.
KURRACHEE . .	1885-86. Calculations completed. 1886-87. Diagrams not read off. A. P.	1886 87. Calculations completed. 1887-88. Diagrams not read off. A. P.
BHÁVNAGAR . .	1886. Calculations completed.	1887. Calculations completed. 1888. Diagrams not read off.
BOMBAY . . .	1886. Diagrams not read off. A. P.	1886. Calculations completed. 1887. Diagrams not read off. A. P.
MORMUGÁO . .	1886-87. Diagrams read off and the hourly readings copied from the S. series into the other series. A. P.	1886-87. Calculations completed. 1887-88. Diagrams not read off. A. P.
COCHIN . . .	1886-87. Calculations completed.	1887-88. Calculations completed.
COLOMBO . . .	1885-86. Calculations completed. 1886-87. Diagrams read off, the hourly readings copied from the S. series into the other series, and the additions of hourly heights of each series ready. A. P.	1886-87. Calculations completed. 1887-88. Diagrams not read off. A. P.
GALLE . . .	1885-86. Calculations completed. 1886-87. Diagrams not read off. A. P.	1886-87. Calculations completed. 1887-88. Diagrams not read off. A. P.
TUTICORIN . . .	... ...	Newly started Observatory. No diagrams read off yet.
NEGAPATAM (closed April 1888).	1885-86. Calculations completed. 1886-87. Calculations completed. A. P.	1887-88. Calculations completed. A. P.
MADRAS . . .	1885-86. Diagrams read off, the hourly readings copied from the S. series into the other series, the additions of hourly heights of each series and the summations of series ready. 1886-87. Diagrams not read off. A. P.	1885-86. Calculations completed. 1886-87. Diagrams read off, the hourly readings copied from the S. series into the other series, and the additions of hourly heights of each series ready. A. P.

State of the ordinary reductions of the yearly tidal registrations, &c.—contd.

Tidal observatory.	State at end of September 1887.	State at end of September 1888.
COCANADA . . .	1886-87. Calculations completed.	1887-88. Calculations completed.
DUBLAT (closed September 1886).	1885-86. Calculations completed. A. P.	
DIAMOND HARBOUR (closed April 1886).	1884-85. Calculations completed. 1885-86. Calculations completed. A. P.	
KIDDERPORE . .	1885-86. Calculations completed. 1886-87. Diagrams not read off. A. P.	1886-87. Diagrams read off, the hourly readings copied from the S. series into the other series, and the additions of hourly heights of each series ready. A. P.
CHITTAGONG . .	1886-87. Calculations completed.	1887-88. Calculations completed.
AKYAB . . .	Newly started observatory. No diagrams read off yet.	1887-88. Calculations completed.
ELEPHANT POINT (closed June 1888).	1885. Calculations completed. 1886. Diagrams not read off. A. P.	1886. Calculations completed. 1887. Calculations completed. 1887-88. Calculations completed. A. P.
RANGOON . . .	1885-86. Calculations incomplete. 1886-87. Diagrams not read off. A. P.	1885-86. Calculations completed. 1886-87. Diagrams read off, the hourly readings copied from the S. series into the other series, and the additions of hourly heights of each series ready. A. P.
AMHERST (closed October 1886).	1884-85. Calculations completed. 1885-86. Calculations completed. A. P.	
MOULMEIN (closed April 1886).	1885-86. Calculations completed. A. P.	
PORT BLAIR . .	1885-86. Diagrams not read off. 1886-87. Diagrams not read off. A. P.	1885-86. Calculations completed. 1886-87. Calculations completed. A. P.

The Tide Tables.

In addition to the calculations already mentioned, the usual work was done in connection with the issue of the Tide Tables, which will contain the predicted heights and times of every high and low water at 28 tidal stations during the year 1889 and January 1890. The values of the constants have been sent to Mr. Roberts, Chief Computer, Nautical Almanac Office, London, ready for use in the Tide Predictor. The mode of calculating them was described in the annual report for 1884-85, and the method employed for the riverain tides will be found described in the Tide Tables in the prefaces to the several riverain stations.

All the prefaces for the next issue of the Tide Tables were prepared by Major Hill, by whom in several cases they were entirely re-written and made final for the stations whose observations were closed.

The final datum for one tidal observatory, Akyab, has been determined from the year's observations and is given below: this information was given for 23 stations in the annual report for 1885-86, and for four others in the last report. So it has now been determined for 28 stations.

Name of Tidal observatory.	Datum to which the height in the Tide Tables for 1889 are referred.	Datum below mean sea-level.
		Feet.
Akyab	Indian spring, low water mark	4·284

The usual five tabular statements are appended, showing the percentage and amount of errors in the predicted times and heights for high and low water for the year 1887, as determined by comparison of the values entered in the Tide Tables for that year, with the actual values obtained by measurements from the tidal diagrams.

No. 1.

Statement showing the Percentage and the amount of the Errors in the Predicted Times of High Water at the various Tidal Stations for the year 1887.

Stations.	Number of comparisons between the actual and predicted values.	Errors of 5 minutes and under.	Errors over 5 minutes and under 15 minutes.	Errors over 15 minutes and under 20 minutes.	Errors over 20 minutes and under 30 minutes.	Errors over 30 minutes.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Aden	697	19	30	17	23	11
Kurrachee	701	17	29	20	26	8
Bombay	705	44	43	7	4	2
Mormugáo	703	24	39	13	18	6
Colombo	688	16	33	13	17	21
Galle	664	35	31	12	11	11
Negapatam	706	19	31	14	19	17
Madras	699	9	23	13	20	35
Kidderpore	702	25	42	14	14	5
Elephant Point	700	26	42	13	16	3
Rangoon	658	31	46	14	7	2
Moulmein	335	33	39	13	11	4
Port Blair	683	24	37	10	16	13

No. 2.

Statement showing the Percentage and the amount of the Errors in the Predicted Times of Low Water at the various Tidal Stations for the year 1887.

Stations.	Number of comparisons between the actual and predicted values.	Errors of 5 minutes and under.	Errors over 5 minutes and under 15 minutes.	Errors over 15 minutes and under 20 minutes.	Errors over 20 minutes and under 30 minutes.	Errors over 30 minutes.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Aden	697	15	28	19	23	15
Kurrachee	701	32	36	13	13	6
Bombay	705	32	43	13	9	3
Mormugáo	701	25	34	14	17	10
Colombo	689	17	26	13	22	22
Galle	665	29	30	10	16	15
Negapatam	704	10	16	7	10	57
Madras	698	17	26	11	14	32
Kidderpore	705	31	43	11	10	5
Elephant Point	699	27	40	11	17	5
Rangoon	652	30	41	15	13	1
Moulmein	334	31	40	9	12	8
Port Blair	684	19	31	11	17	22

No. 3.

Statement showing the Percentage and the amount of the Errors in the Predicted Heights of High Water at the various Tidal Stations for the year 1887.

Stations.	Number of comparisons between the actual and predicted values.	Errors of 4 inches and under.	Errors over 4 inches and under 8 inches.	Errors over 8 inches and under 12 inches.	Errors over 12 inches.
		Per cent.	Per cent.	Per cent.	Per cent.
Aden	697	55	41	4	...
Kurrachee	701	81	17	1	1
Bombay	705	69	25	6	...
Mormugáo	703	84	14	2	...
Colombo	688	95	5	...	...
Galle	664	93	7	...	...
Negapatam	706	83	16	1	...
Madras	699	65	29	6	...
Kidderpore	702	43	21	12	24
Elephant Point	700	46	25	11	18
Rangoon	658	39	31	18	12
Moulmein	335	51	21	12	16
Port Blair	683	96	4	...	...

No. 4.

Statement showing the Percentage and the amount of the Errors in the Predicted Heights of Low Water at the various Tidal Stations for the year 1887.

Stations.	Number of comparisons between the actual and predicted values.	Errors of 4 inches and under.	Errors over 4 inches and under 8 inches.	Errors over 8 inches and under 12 inches.	Errors over 12 inches.
		Per cent.	Per cent.	Per cent.	Per cent.
Aden	697	51	46	3	...
Kurrachee	701	69	25	5	1
Bombay	705	68	25	6	1
Mormugáo	701	73	26	1	...
Colombo	689	83	17	...	...
Galle	665	87	13	...	...
Negapatam	704	77	20	3	...
Madras	698	85	13	2	...
Kidderpore	705	35	24	14	27
Elephant Point	699	47	24	11	18
Rangoon	652	39	27	13	21
Moulmein	334	37	23	13	27
Port Blair	684	95	5	...	...

No. 5.

Table of Average Errors in the Predicted Times and Heights of High and Low Water at the several Tidal Stations for the year 1887.

Stations.	Mean Range at Springs, in feet.	Average Errors					
		Of Time, in minutes.		Of Height, in terms of the Range.		Of Height, in inches.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
Aden	6·7	17	18	·050	·050	4	4
Kurrachee	9·7	16	12	·026	·034	3	4
Bombay	14·5	8	11	·023	·023	4	4
Mormugáo	7·0	14	15	·036	·036	3	3
Colombo	2·4	20	21	·069	·104	2	3
Galle	2·2	14	17	·076	·076	2	2
Negapatam	2·6	18	40	·064	·096	2	3
Madras	3·5	26	25	·091	·071	4	3
Kidderpore	11·7	13	12	·064	·071	9	10
Elephant Point	19·2	12	13	·030	·030	7	7
Rangoon	16·4	10	11	·036	·040	7	8
Moulmein	12·7	11	12	·046	·066	7	10
Port Blair	6·6	15	20	·025	·025	2	2

It has been the custom to send yearly to Mr. Roberts the actual times and heights of high and low water at all the riverain ports, in order that he might use them for correcting the predictions at these ports. This year a much larger amount of information has been extracted and tabulated with a view to its use in correcting the predictions; the actual errors in time and height of each low and high water have been taken out and tabulated for thirteen ports, being those at which tidal operations are still in progress, and for which Tide Tables have been constructed in 1887-88. This information will, it is hoped, enable Mr. Roberts to form an idea as to the correctness of the Tide Tables as turned out by the Tide Predictor, and possibly aid him in making improvements where necessary in the open coast ports, where the predictions of time seem to have deteriorated.

Bench-marks.

During the inspection of each tidal observatory the bench-marks of reference are connected by levelling with each other and with the bed-plate of the gauge, and during the year under report they were found generally in a satisfactory condition, with the following exceptions:—

At *Mormugáo*, the bench-mark of reference was found to have sunk 0·146 foot, owing probably to alterations and heavy traffic on the railway platform on which it is situated.

At *Akyab*, bench-mark A appears to have sunk somewhat, and bench-mark B has been adopted as the standard of reference.

New bench-marks of reference have been fixed at the undermentioned stations:—

Bhávnagar.—23 feet south-west of the old bench-mark, at the top of the incline leading down to the steam ferry; its height has been determined as 43·392 feet above the zero of the gauge.

Tuticorin.—The bench-marks of reference for this new observatory are Nos. 46 and 47 in Section Ramnad to Tuticorin of the Spirit-levelled Heights No. 2, Madras Presidency, Season 1885-86.

Chittagong.—A third bench-mark, consisting of a masonry pillar situated near a cocoa-nut tree, on the east side of the iron jetty, with figures 2350 cut upon it, has been connected with the bed-plate.

Rangoon.—The bench-mark of reference described in last year's narrative report has been fixed in position and connected by levelling with the original marks A and C, and it now forms the permanent bench-mark of reference for Burma.

During the year under report three pairs of test bench-marks were laid down in connection with the tidal stations; one pair at each of the stations of Cocanada, False Point and Vizagapatam.

Levelling Operations.

The operations of the last field season comprised the following lines of double levelling:—

I.—From Madras to Vizagapatam *viâ* Nellore, Guntúr and Cocanada.

II.—At False Point, to connect the Marine Survey bench-marks with the main line of levels.

III.—From Chinsurah to Nuddea along the right bank of the Hooghly.

Sections I and II were carried out by Mr. Cusson. He worked with the rectangular level, and his assistant, Sub-Surveyor Narsing Das, worked with the cylindrical level. They left Poona for the field on the 24th October and returned on the 23rd May, after a field season of exactly 7 months. The outturn of work is very creditable, being 507 miles of levelling along the main line and 38½ miles of branches; in all 545½ miles, involving a rise and fall of 12,423 feet. The instruments were set up 3,796 times, and in the course of their work 47 embedded and 457 ordinary bench-marks were connected. Besides these 10 Great Trigonometrical Stations, 45 Public Works Department, 2 Marine Survey, and 4 Railway bench-marks were connected.

This is a considerably larger outturn than the previous season's, due probably in part to the fact that the levelling was nearly continuous, and the party had not to be moved from one part of the country to another during the field season, but also due to the hard work and application of the levellers.

On the completion of the line of levels at Vizagapatam, Mr. Cusson's party proceeded to False Point to connect the bench-mark there with the G. T. bench-mark at False Point Lighthouse on the main line of levels. The False Point bench-mark had been made by Lieutenant Petley after the great storm wave of September 1885, which destroyed the tide gauge and its bench-marks. He obtained an approximate value for his bench-mark from the remains of the old staff of the tide gauge, but it was of importance that its true level should be known.

The distance to be levelled was only 9 miles, and in addition Mr. Cusson found and embedded in safe positions the two old bench-marks A and C.

The following extracts are taken from the report submitted to me by Mr. Cusson on his last season's work:—

* * * *

"(*a*) My instructions were to carry a double line of levels from Madras to Vizagapatam with short branch lines intermediately, to connect with the tidal station at Cocanada, and with as many stations of the principal triangulation as would fall within convenient reach of the operations. The origin of the line of levels fixed upon was the test bench-mark embedded at the Carnatic Mill, Perambúr."

* * * *

"(*b*) On closing the first day's work at the embedded bench-mark at the Sembian police station, one of the test bench-marks of the tidal station at Madras, I found, on comparing the results obtained with the heights given in the pamphlet of Spirit-levelled Heights No. 1, Madras Presidency, that the bench-mark at the Carnatic Mill had sunk by 0·048 foot. In consequence the test bench-mark at the Sembian Police Station has been made, with your sanction, the origin of the season's levelling operations instead."

"(*c*) The work was conducted steadily throughout the month of November, which is the rainiest on that coast, amid great hardships and discomfort, not only from the daily drenching we all got, but also from the inundated condition of the country in which we had to camp. On crossing the river Swarnamukhi, however, we had the satisfaction of having firm ground under our feet instead of swamp. Nellore, which was the closing point of the first section of the work, was reached on the 15th December."

* * * *

"(*d*) The second section of the work was from Nellore to Guntúr, where I arrived on the 3rd of February. The third section was from Guntúr to Rajahmundry, and a few days after commencing it we had to cross the Kistna by the anicut, which had a pile of loose stones laid along its entire length to enable people to cross the river in safety, as the water due to the recent rains had risen considerably. The passage, I need hardly say, was attended with great risks, particularly to those encumbered with burdens, as the loose boulders often shifted or gave way under their feet, as they carefully picked their way along with sticks to support them."

* * * *

"(*e*) The work was carried along the main road according to my instructions, up to the boundary between Kistna district and Ellore, where it disappears, having fallen into disuse owing to the navigable canal from Bezváda on the Kistna to Dowlaishweram on the Godávari, which is now the highway of traffic and passengers. Accordingly, from the village of Valtúr I fell back on the canal, as it afforded every facility for the work and had bench-marks at every furlong. Soon after this I crossed the Godávari, carrying my line of levels along the four anicuts which stretch across the channels of the river formed by small islands opposite Dowlaishweram."

* * * *

(*f*) "The work was continued from Cocanada to Vizagapatam along the main road as at first, forming

the 4th section. Towards the close of April the weather became boisterous, and before we closed at Vizagapatam, it used to blow a perfect gale all day, and it was with the utmost difficulty that we contrived to continue the work up to Vizagapatam, where I arrived on the 2nd of May and connected all the bench-marks that could be found."

* * * *

"(g) About this time I received further instructions to proceed to False Point, and connect by levelling a bench-mark built by Lieutenant Petley, R.N., with the one at the light-house, which had in no way been disturbed by the disastrous cyclone of the 22nd September 1885. On my arrival there I found that the bench-mark had in reality been built by the Native Overseer employed upon the construction of the new refuge house, solely to enable him to see that the contractor built it to the required height above Lieutenant Petley's datum, which is marked on the south-east pile of the old refuge house. As, however, no thought had been taken to place it above the reach of the waves even in an ordinary inundation, I found it necessary to embed two test bench-marks on the plinth at the eastern and western ends of the new house, 27 feet above mean sea-level. The Executive Engineer in charge of the works arrived at False Point a few days after and told me the waves during the late cyclone touched 20 feet above mean sea-level, so that the old refuge house could have served no useful purpose even if there had been greater facilities for taking shelter there."

Lieutenant Petley, R.N., having requested that the levelling along the bank of the Hooghly, which had terminated at Chinsurah, might be carried on as far as Nuddea, in order to provide bench-marks for the river survey, a small temporary party for this purpose was organised under Mr. Belcham.

Mr. Belcham, with Sub-Surveyor Venayek Narayen as second leveller, proceeded to Calcutta, where he organised a small party and commenced his levels at Chinsurah, where bench-marks had been laid down in 1882-83. The instruments used were cylindrical Levels Nos. 1 and 3. The work was commenced on the 14th December and finished on the 19th January. The total length of the line of levels was 50 miles, and lies along the right bank of the Hooghly; from Chinsurah to Nuddea, 13 embedded and 23 inscribed bench-marks were laid down in the course of the work.

A small amount of levelling was also done in Poona during this season, its object being to obtain true values for the bench-marks Nos. 115 and $\frac{1}{116}$, at page 14 of pamphlet of Spirit-levelled Heights Nos. 2 and 3. Bombay Presidency, Seasons 1877-80, revised edition. These bench-marks situated in the railway station had been disturbed by repairs, so a line of 2 miles was levelled between two fixed bench-marks, whereby the correct values of the altered bench-marks were obtained and three new ones were laid down.

Values of the Tidal Constants, Aden, 1886-87.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1886-87 observations at Aden; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1886-87 observations. The values of the amplitudes R and H are expressed in terms of British feet.

Short Period Tides.

$A_0 = 5{\cdot}902$ feet.

S_1	H = R =	·070	M_6	R =	·005	Q_1	R =	·121	T_2	R =	·027
	κ = ζ =	170°·58		ζ =	195°·46		ζ =	59°·40		ζ =	234°·07
S_2	H = R =	·700		H =	·005		H =	·147		H =	·027
	κ = ζ =	246°·98		κ =	350°·46		κ =	43°·04		κ =	173°·99
S_4	H = R =	·004	M_8	R =	·003	L_2	R =	·047	$(MS)_4$	R =	·012
	κ = ζ =	318°·24		ζ =	267° 80		ζ =	165°·24		ζ =	94°·64
S_6	H = R =	·006		H =	·003		H =	·048		H =	·011
	κ = ζ =	214°·19		κ =	114°·46		κ =	229°·34		κ =	146°·30
S_8	H = R =	·001	O_1	R =	·550	N_2	R =	·443	$(2SM)_2$	R =	·025
	κ = ζ =	340°·02		ζ =	229°·91		ζ =	352°·79		ζ =	160°·90
				H =	·666		H =	·428		H =	·024
				κ =	36°·75		κ =	221°·25		κ =	109°·23
M_1	R =	·052	K_1	R =	1·163	λ_2	R =	...	$2N_2$	R =	·069
	ζ =	0°·03		ζ =	148° 57		ζ =	...		ζ =	148°·62
	H =	·036		H =	1·301		H =	...		H =	·067
	κ =	97°·46		κ =	35°·62		κ =	...		κ =	193°·88
M_2	R =	1·625	K_2	R =	·164	ν_2	R =	·007	$(M_2N)_4$	R =	·033
	ζ =	175°·04		ζ =	289°·24		ζ =	307°·81		ζ =	130°·15
	H =	1·570		H =	·213		H =	·007		H =	·031
	κ =	226°·71		κ =	244°·04		κ =	235°·17		κ =	50°·28
M_3	R =	·020	P_1	R =	·391	μ_2	R =	·060	$(M_2K_1)_3$	R =	·020
	ζ =	141°·75		ζ =	282°·20		ζ =	91°·16		ζ =	329°·14
	H =	·019		H =	·391		H =	·056		H =	·021
	κ =	219°·24		κ =	31°·14		κ =	194°·49		κ =	267°·85
M_4	R =	·006	J_1	R =	·074	R_2	R =	...	$(2M_2K_1)_3$	R =	·001
	ζ =	228°·62		ζ =	320°·13		ζ =	...		ζ =	249°·44
	H =	·006		H =	·087		H =	...		H =	·001
	κ =	331°·95		κ =	28°·15		κ =	...		κ =	105°·73

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·041	247°·21	0·037	70°·41
„ Fortnightly „	0·043	112·09	0·065	10·07
Luni-Solar „ „	0·016	161·94	0·015	110·27
Solar Annual „	0·403	30·09	0·403	11·16
„ Semi-Annual „	0·166	184·74	0·166	146·86

Values of the Tidal Constants, Kurrachee, 1886-87.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1886-87 observations at Kurrachee; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1886-87 observations. The values of the amplitudes R and H are expressed in terms of British feet.

Short Period Tides.

$A_0 = 7{\cdot}225$ feet.

S_1	H = R =	·077	M_6	R =	·048	Q_1	R =	·123	T_2	R =	·036
	κ = ζ =	179°·18		ζ =	35°·84		ζ =	170°·15		ζ =	165°·81
S_2	H = R =	·972		H =	·044		H =	·148		H =	·036
	κ = ζ =	322°·84		κ =	199°·44		κ =	49°·26		κ =	47°·64
S_4	H = R =	·008	M_8	R =	·004	L_2	R =	·067	$(MS)_4$	R =	·027
	κ = ζ =	26°·25		ζ =	349°·35		ζ =	198°·54		ζ =	286°·29
S_6	H = R =	·010		H =	·003		H =	·072		H =	·026
	κ = ζ =	284°·04		κ =	198°·47		κ =	314°·99		κ =	340°·82
S_8	H = R =	·002	O_1	R =	·558	N_2	R =	·634	$(2SM)_2$	R =	·026
	κ = ζ =	82°·24		ζ =	293°·29		ζ =	97°·13		ζ =	163°·15
				H =	·671		H =	·613		H =	·025
				κ =	45°·64		κ =	278°·42		κ =	108°·62
M_1	R =	·069	K_1	R =	1·176	λ_2	R =	...	$2N_2$	R =	·077
	ζ =	352°·78		ζ =	101°·75		ζ =	...		ζ =	318°·82
	H =	·046		H =	1·310		H =	...		H =	·075
	κ =	95°·29		κ =	46°·40		κ =	...		κ =	266°·87
M_2	R =	2·651	K_2	R =	·202	ν_2	R =	·176	$(M_2N)_4$	R =	·087
	ζ =	238°·64		ζ =	254°·50		ζ =	262°·82		ζ =	222°·06
	H =	2·564		H =	·262		H =	·171		H =	·081
	κ =	293°·17		κ =	324°·55		κ =	246°·06		κ =	97°·88
M_3	R =	·049	P_1	R =	·382	μ_2	R =	·048	$(M_2K_1)_3$	R =	·061
	ζ =	251°·45		ζ =	354°·13		ζ =	148°·27		ζ =	60°·77
	H =	·047		H =	·382		H =	·045		H =	·066
	κ =	333°·25		κ =	44°·97		κ =	257°·33		κ =	59°·94
M_4	R =	·039	J_1	R =	·071	R_2	R =	...	$(2M_2K_1)_3$	R =	·015
	ζ =	239°·14		ζ =	226°·71		ζ =	...		ζ =	179° 60
	H =	·037		H =	·084		H =	...		H =	·015
	κ =	348°·20		κ =	42°·13		κ =	...		κ =	344°·02

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·018	58°·10	0·016	291°·35
„ Fortnightly „	0·035	20·76	0·052	30·57
Luni-Solar „ „	0·004	225·37	0·004	170·84
Solar Annual „	0·182	41·69	0·182	80·84
„ Semi-Annual „	0·253	63·87	0·253	142·18

Values of the Tidal Constants, Bhávnagar, 1887.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1887 observations at Bhávnagar; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1887 observations. The values of the amplitudes R and H are expressed in term of British feet:—

Short Period Tides.

$A_0 = 22{\cdot}710$ feet.

S_1	H =		·129	M_6	R =		·239	Q_1	R =		·178
	R =		·129		ζ =		241°·69		ζ =		261°·46
	κ =	ζ =	186°·13		H =		·219		H =		·207
S_2	H =		3·414		κ =		124°·73		κ =		87°·53
	R =		3·414	M_8	R =		·023	L_2	R =		·605
	κ =	ζ =	175°·54		ζ =		45°·64		ζ =		293°·21
S_4	H =		·126		H =		·021		H =		·735
	R =		·126		κ =		129°·69		κ =		149°·50
	κ =	ζ =	230°·28	O_1	R =		·852	N_2	R =		2·595
S_6	H =		·025		ζ =		63°·78		ζ =		106°·03
	R =		·025		H =		·989		H =		2·521
	κ =	ζ =	296°·98		κ =		83°·82		κ =		113°·07
S_8	H =		·007	K_1	R =		2·126	γ_2	R =		...
	R =		·007		ζ =		266°·77		ζ =		...
	κ =	ζ =	94°·21		H =		2·323		H =		...
M_1	R =		·217		κ =		91°·08		κ =		...
	ζ =		147°·76	K_2	R =		·690	ν_2	R =		·957
	H =		·126		ζ =		346°·98		ζ =		230°·24
	κ =		156°·79		H =		·859		H =		·930
M_2	R =		11·038		κ =		176°·42		κ =		107°·59
	ζ =		293°·87	P_1	R =		·680	μ_2	R =		·275
	H =		10·724		ζ =		284°·69		ζ =		245°·04
	κ =		134°·88		H =		·680		H =		·260
M_3	R =		·118		κ =		94°·07		κ =		287°·06
	ζ =		206°·83	J_1	R =		·085	R_2	R =		...
	H =		·113		ζ =		122°·66		ζ =		...
	κ =		328°·35		H =		·096		H =		...
M_4	R =		·971		κ =		137°·60		κ =		...
	ζ =		110°·91								
	H =		·916								
	κ =		152°·93								

T_2	R =		·277	$(MS)_4$	R =		·703	$(2SM)_2$	R =		·059
	ζ =		246°·19		ζ =		356°·14		ζ =		194°·20
	H =		·277		H =		·683		H =		·057
	κ =		246°·57		κ =		197°·15		κ =		353°·19
$2N_2$	R =		·134	$(M_2N)_4$	R =		·451	$(M_2K_1)_3$	R =		·307
	ζ =		214°·22		ζ =		244°·51		ζ =		80°·31
	H =		·130		H =		·425		H =		·326
	κ =		27°·28		κ =		92°·56		κ =		105°·63
$(2M_2K_1)_3$	R =		·121								
	ζ =		132°·70								
	H =		·125								
	κ =		350°·42								

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·146	205°·07	0·133	39°·05
„ Fortnightly „	0·038	63 ·02	0·053	43 ·94
Luni-Solar „ „	0·226	241 ·36	0·220	40 ·35
Solar Annual „	0·375	194 ·51	0·375	115 ·13
„ Semi-Annual „	0·271	327 ·55	0·271	168 ·79

Values of the Tidal Constants, Bombay, 1886.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1886 observations at Bombay; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1886 observations. The values of the amplitudes R and H are expressed in terms of British feet:—

Short Period Tides.

$A_0 = 10{\cdot}267$ feet.

S_1	H =		·059	M_6	R =		·007	Q_1	R =		·109
	R =		·059		ζ =		108°·14		ζ =		229°·62
	κ =	ζ =	186°·18		H =		·006		H =		·133
S_2	H =		1·628		κ =		50°·94		κ =		39°·89
	R =		1·628	M_8	R =		·006	L_2	R =		·095
	κ =	ζ =	3°·01		ζ =		308°·29		ζ =		287°·43
S_4	H =		·011		H =		·005		H =		·095
	R =		·011		κ =		352°·03		κ =		322°·94
	κ =	ζ =	251°·57								
S_6	H =		·003								
	R =		·003								
	κ =	ζ =	259°·88								

T_2	R =		...	$(MS)_4$	R =		·142				
	ζ =		...		ζ =		282°·33				
	H =		...		H =		·137				
	κ =		...		κ =		23°·26				

Short Period Tides—contd.

$A_0 = 10{\cdot}267$ feet.

S_8	H =		·002	O_1	R =		·539	N_2	R =		1·037	$(2SM)_2$	R =		·030
	κ =	ζ =	108°·44		ζ =		132°·41		ζ =		316°·18		ζ =		199°·11
M_1	R =		·004		H =		·657		H =		1·001		H =		·029
	ζ =		156°·62		κ =		47°·91		κ =		311°·89		κ =		98°·17
	H =		·003	K_1	R =		1·251	λ_2	R =		...	$2N_2$	R =		·188
	κ =		274°·53		ζ =		217°·92		ζ =		...		ζ =		27°·83
M_2	R =		4·185		H =		1·405		H =		...		H =		·182
	ζ =		228°·62		κ =		45°·30		κ =		...		κ =		278°·31
	H =		4·041	K_2	R =		·277	ν_2	R =		·218	$(M_2N)_4$	R =		·102
	κ =		329°·56		ζ =		156°·42		ζ =		40°·59		ζ =		195°·30
M_3	R =		·083		H =		·364		H =		·210		H =		·096
	ζ =		233°·61		κ =		351°·81		κ =		348°·41		κ =		291°·94
	H =		·079	P_1	R =		·404	μ_2	R =		·199	$(M_2K_1)_3$	R =		·090
	κ =		25°·01		ζ =		234°·99		ζ =		115°·21		ζ =		252°·41
M_4	R =		·150		H =		·404		H =		·185		H =		·098
	ζ =		121°·79		κ =		44°·13		κ =		317°·08		κ =		180°·73
	H =		·140	J_1	R =		·041	R_2	R =		...	$(2M_2K_1)_3$	R =		·059
	κ =		323°·65		ζ =		159°·41		ζ =		...		ζ =		34°·63
					H =		·048		H =		...		H =		·062
					κ =		90°·07		κ =		...		κ =		49°·11

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·051	178°·45	0·045	283°·67
„ Fortnightly „	0·040	333·74	0·061	63·66
Luni-Solar „ „	0·037	299·13	0·036	198·20
Solar Annual „	0·110	95·67	0·110	16·53
„ Semi-Annual „	0·176	305·99	0·176	147·71

Values of the Tidal Constants, Mormugáo, 1886-87.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1886-87 observations at Mormugáo; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1886-87 observations. The values of the amplitudes R and H are expressed in terms of British feet:—

Short Period Tides.

$A_0 = 5{\cdot}573$ feet.

S_1	H =		·047	M_6	R =		·013	Q_1	R =		·092	T_2	R =		...
	κ =	ζ =	171°·52		ζ =		324°·29		ζ =		194°·57		ζ =		...
S_2	H =		·643		H =		·012		H =		·111		H =		...
	κ =	ζ =	330°·54		κ =		254°·19		κ =		41°·80		κ =		...
S_4	H =		·008	M_8	R =		·019	L_2	R =		·037	$(MS)_4$	R =		·025
	κ =	ζ =	89°·25		ζ =		349°·76		ζ =		24°·96		ζ =		307°·77
S_6	H =		·004		H =		·017		H =		·039		H =		·025
	κ =	ζ =	127°·48		κ =		16°·29		κ =		302°·74		κ =		44°·40
S_8	H =		·003	O_1	R =		·430	N_2	R =		·442	$(2SM)_2$	R =		·007
	κ =	ζ =	30°·58		ζ =		208°·61		ζ =		176°·52		ζ =		166°·81
M_1	R =		·022		H =		·520		H =		·427		H =		·007
	ζ =		102°·39		κ =		47°·85		κ =		281°·15		κ =		70°·18
	H =		·015	K_1	R =		·918	λ_2	R =		...	$2N_2$	R =		·077
	κ =		43°·12		ζ =		145°·16		ζ =		...		ζ =		126°·25
M_2	R =		1·898		H =		1·026		H =		...		H =		·074
	ζ =		202°·72		κ =		44°·84		κ =		...		κ =		238°·87
	H =		1·835	K_2	R =		·157	ν_2	R =		·019	$(M_2N)_4$	R =		·024
	κ =		299°·36		ζ =		344°·07		ζ =		47°·15		ζ =		135°·72
					H =		·205		H =		·018		H =		·022
					κ =		324°·14		κ =		233°·27		κ =		336°·98

Short Period Tides—contd.

$A_0 = 5{\cdot}573$ feet.

M_3	R =	·018	P_1	R =	·289	μ_2	R =	·062	$(M_2K_1)_3$	R =	·036
	ζ =	330°·70		ζ =	305°·54		ζ =	55°·03		ζ =	111°·92
	H =	·017		H =	·289		H =	·058		H =	·039
	κ =	295°·64		κ =	41°·74		κ =	248°·30		κ =	108°·23
M_4	R =	·055	J_1	R =	·064	R_2	R =	...	$(2M_2K_1)_3$	R =	·005
	ζ =	172°·33		ζ =	181°·17		ζ =	...		ζ =	157°·99
	H =	·051		H =	·075		H =	...		H =	·005
	κ =	5°·60		κ =	70°·57		κ =	...		κ =	91°·58

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·017	293°·61	0·015	285°·62
„ Fortnightly „	0·059	133 ·09	0·089	11 ·24
Luni-Solar „ „	0 042	90 ·64	0·041	354 ·01
Solar Annual „	0·291	333 ·73	0·291	327 ·53
„ Semi-Annual „	0·133	159 ·78	0·133	147 ·38

Values of the Tidal Constants, Cochin, 1887-88.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1887-88 observations at Cochin; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1887-88 observations. The values of the amplitudes R and H are expressed in terms of British feet:—

Short Period Tides.

$A_0 = 2{\cdot}359$ feet.

S_1	H = R =	·039	M_6	R =	·012	Q_1	R =	·071	T_2	R =	·058
	κ = ζ =	226°·56		ζ =	151°·60		ζ =	77°·29		ζ =	32°·19
S_2	H = R =	·270		H =	·011		H =	·082		H =	·058
	κ = ζ =	37°·09		κ =	79°·89		κ =	61°·60		κ =	8°·92
S_4	H = R =	·008	M_8	R =	·004	L_2	R =	·033	$(MS)_4$	R =	·019
	κ = ζ =	138°·24		ζ =	107°·82		ζ =	28°·67		ζ =	167°·37
S_6	H = R =	·005		H =	·003		H =	·041		H =	·018
	κ = ζ =	222°·44		κ =	12°·21		κ =	332°·37		κ =	143°·47
S_8	H = R =	·002	O_1	R =	·282	N_2	R =	·181	$(2SM)_2$	R =	·009
	κ = ζ =	296°·57		ζ =	284°·32		ζ =	111°·20		ζ =	104°·65
				H =	·326		H =	·175		H =	·009
				κ =	56°·03		κ =	299°·91		κ =	128°·55
M_1	R =	·014	K_1	R =	·552	λ_2	R =	...	$2N_2$	R =	·022
	ζ =	9°·20		ζ =	204°·89		ζ =	...		ζ =	144°·13
	H =	·008		H =	·602		H =	...		H =	·022
	κ =	87°·01		κ =	52°·68		κ =	...		κ =	185°·45
M_2	R =	·752	K_2	R =	·051	ν_2	R =	·054	$(M_2N)_4$	R =	·015
	ζ =	354°·38		ζ =	144°·22		ζ =	233°·52		ζ =	260°·13
	H =	·731		H =	·063		H =	·053		H =	·014
	κ =	330°·48		κ =	20°·65		κ =	334°·48		κ =	64°·94
M_3	R =	·004	P_1	R =	·175	μ_2	R =	·034	$(M_2K_1)_3$	R =	·023
	ζ =	300°·70		ζ =	257°·14		ζ =	251°·40		ζ =	313°·92
	H =	·004		H =	·175		H =	·032		H =	·025
	κ =	264°·85		κ =	42°·88		κ =	203°·60		κ =	137°·81
M_4	R =	·027	J_1	R =	·035	R_2	R =	...	$(2M_2K_1)_3$	R =	·020
	ζ =	112°·10		ζ =	56°·82		ζ =	...		ζ =	3°·83
	H =	·025		H =	·039		H =	...		H =	·021
	κ =	64°·29		κ =	48°·60		κ =	...		κ =	108°·24

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·038	324°·50	0·035	111°·89
„ Fortnightly „	0·052	143·71	0·072	36·39
Luni-Solar „ „	0·043	287·00	0·042	310·90
Solar Annual „	0·418	352·23	0·418	296·49
„ Semi-Annual „	0·161	272·37	0·161	160·90

Values of the Tidal Constants, Galle, 1886-87.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1886-87 observations at Galle; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1886-87 observations. The values of the amplitudes R and H are expressed in terms of British feet :—

Short Period Tides.

$A_0 = 2·679$ feet.

S_1	H=	R =	·031	M_6	R =	·004	Q_1	R=	·023	T_2	R =	...
	κ =	ζ =	27°·87		ζ =	183°·47		ζ =	141°·53		ζ =	...
S_2	H=	R =	·370		H =	·003		H=	·028		H =	...
	κ =	ζ =	91°·80		κ =	24°·27		κ =	94°·72		κ =	...
S_4	H=	R =	·002	M_8	R =	·002	L_2	R=	·040	$(MS)_4$	R =	·009
	κ =	ζ =	252°·65		ζ =	347°·59		ζ =	343°·23		ζ =	171°·31
S_6	H=	R =	·004		H =	·001		H=	·042		H =	·009
	κ =	ζ =	106°·14		κ =	255°·33		κ =	79°·98		κ =	238°·24
S_8	H=	R =	·001	O_1	R =	·038	N_2	R=	·056	$(2SM)_2$	R =	·009
	κ =	ζ =	274°·09		ζ =	284°·48		ζ =	178°·64		ζ =	26°·87
					H =	·046		H=	·054		H =	·008
					κ =	78°·47		κ =	44°·77		κ =	319°·94
M_1	R =		·005	K_1	R =	·150	λ_2	R=	...	$2N_2$	R =	·009
	ζ =		225°·79		ζ =	100°·37		ζ =	...		ζ =	123°·33
	H =		·004		H =	·168		H=	...		H =	·009
	κ =		332°·67		κ =	15°·66		κ =	...		κ =	148°·64
M_2	R =		·548	K_2	R =	·118	ν_2	R=	·014	$(M_2N)_4$	R =	·026
	ζ =		348°·02		ζ =	89°·66		ζ =	15°·77		ζ =	256°·25
	H =		·530		H =	·154		H=	·013		H =	·024
	κ =		54°·95		κ =	100°·97		κ =	351°·33		κ =	189°·31
M_3	R =		·015	P_1	R =	·037	μ_2	R=	·028	$(M_2K_1)_3$	R =	·005
	ζ =		49°·57		ζ =	303°·73		ζ =	326°·25		ζ =	144°·32
	H =		·014		H =	·037		H=	·026		H =	·005
	κ =		149°·98		κ =	24°·19		κ =	100°·12		κ =	126°·55
M_4	R =		·013	J_1	R =	·010	R_2	R=	...	$(2M_2K_1)_3$	R =	·003
	ζ =		32°·57		ζ =	241°·66		ζ =	...		ζ =	223°·73
	H =		·013		H =	·012		H=	...		H =	·003
	κ =		166°·44		κ =	355°·41		κ =	...		κ =	82°·31

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·019	139°·14	0·017	339°·95
„ Fortnightly „	0·044	39·78	0·066	338·73
Luni-Solar „ „	0·031	334·45	0·030	267·51
Solar Annual „	0·346	302·23	0·346	311·78
„ Semi-Annual „	0·142	102·73	0·142	121·83

Values of the Tidal Constants, Colombo, 1886-87.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1886-87 observations at Colombo; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1886-87 observations. The values of the amplitudes R and H are expressed in terms of British feet:—

Short Period Tides.

$A_0 = 2{\cdot}304$ feet.

S_1	H =	·003	M_6	R =	·005	Q_1	R =	·025	T_2	R =	...
	κ = ζ =	142°·77		ζ =	149°·47		ζ =	21°·76		ζ =	...
S_2	H = R =	·404		H =	·005		H =	·031		H =	...
	κ = ζ =	90°·30		κ =	346°·03		κ =	81°·74		κ =	...
S_4	H = R =	·004	M_8	R =	·000	L_2	R =	·037	$(MS)_4$	R =	·009
	κ = ζ =	225°·94		ζ =	243°·44		ζ =	19°·56		ζ =	194°·81
S_6	H = R =	·002		H =	·000		H =	·038		H =	·009
	κ = ζ =	144°·16		κ =	145°·52		κ =	64°·41		κ =	260°·33
S_8	H = R =	·000	O_1	R =	·075	N_2	R =	·076	$(2SM)_2$	R =	·008
	κ = ζ =	108°·44		ζ =	209°·26		ζ =	114° 41		ζ =	62°·80
				H =	·091		H =	·073		H =	·008
				κ =	59°·23		κ =	29°·94		κ =	357°·28
M_1	R =	·009	K_1	R =	·213	λ_2	R =	·016	$2N_2$	R =	·009
	ζ =	186°·48		ζ =	171°·62		ζ =	347°·17		ζ =	250°·07
	H =	·006		H =	·239		H =	·016		H =	·008
	κ =	288°·84		κ =	29°·26		κ =	16°·40		κ =	15°·61
M_2	R =	·611	K_2	R =	·096	ν_2	R =	·012	$(M_2N)_4$	R =	·010
	ζ =	340°·31		ζ =	188°·78		ζ =	154°·54		ζ =	280°·95
	H =	·590		H =	·126		H =	·011		H =	·009
	κ =	45°·83		κ =	84°·74		κ =	76°·34		κ =	262°·00
M_3	R =	·015	P_1	R =	·068	μ_2	R =	·020	$(M_2K_1)_3$	R =	·007
	ζ =	63°·08		ζ =	251°·27		ζ =	351°·41		ζ =	104°·25
	H =	·014		H =	·068		H =	·018		H =	·007
	κ =	161°·36		κ =	29°·87		κ =	122°·45		κ =	27°·42
M_4	R =	·019	J_1	R =	·011	R_2	R =	...	$(2M_2K_1)_3$	R =	·005
	ζ =	33°·51		ζ =	356°·26		ζ =	...		ζ =	173°·16
	H =	·017		H =	·013		H =	...		H =	·005
	κ =	164°·55		κ =	1°·80		κ =	...		κ =	86°·55

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	0·045	233°·99	0·040	23°·98
„ Fortnightly „ . . .	0·032	157 ·93	0·049	343 ·51
Luni-Solar „ „ . . .	0·027	340 ·35	0·026	274 ·83
Solar Annual „ . . .	0·323	3 ·31	0·323	314 ·71
„ Semi-Annual „ . . .	0·155	219 ·14	0·155	121 ·94

Values of the Tidal Constants, Negapatam, 1887-88.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1887-88 observations at Negapatam; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1887-88 observations. The values of the amplitudes R and H are expressed in terms of British feet.

Short Period Tides.

$A_0 = 2{\cdot}047$ feet.

S_1	H = R =	·055	M_6	R =	·009	Q_1	R =	·003	T_2	R =	...
	κ = ζ =	120°·32		ζ =	194°·53		ζ =	324°·69		ζ =	...
S_2	H = R =	·249		H =	·009		H =	·003		H =	...
	κ = ζ =	285°·44		κ =	133°·53		κ =	34°·46		κ =	...
S_4	H = R =	·004	M_8	R =	·001	L_2	R =	·025	$(MS)_4$	R =	·025
	κ = ζ =	139°·69		ζ =	110°·56		ζ =	222°·02		ζ =	11°·60
S_6	H = R =	·002		H =	·001		H =	·030		H =	·024
	κ = ζ =	97°·60		κ =	149°·21		κ =	272°·14		κ =	111°·26

Short Period Tides—contd.

$A_0 = 2{\cdot}0.17$ feet.

S_8	H=	R =	·000	O_1	R =	·076	N_2	R =	·161	$(2SM)_2$	R =	·007
	κ =	ζ =	153°·44		ζ =	118°·72		ζ =	272°·56		ζ =	307°·41
					H =	·038		H =	·157		H =	·006
					κ =	321°·25		κ =	239°·46		κ =	207°·74
M_1	R =		·015	K_1	R =	·193	λ_2	R =	...	$2N_2$	R =	·021
	ζ =		221°·37		ζ =	88°·37		ζ =	...		ζ =	19°·60
	H =		·008		H =	·210		H =	...		H =	·020
	κ =		3°·75		κ =	349°·04		κ =	...		κ =	213°·73
M_2	R =		·672	K_2	R =	·075	ν_2	R =	·020	$(M_2N)_4$	R =	·023
	ζ =		153°·08		ζ =	299°·76		ζ =	305°·67		ζ =	88°·72
	H =		·654		H =	·091		H =	·020		H =	·022
	κ =		252°·74		κ =	281°·93		κ =	279°·22		κ =	155°·28
M_3	R =		·004	P_1	R =	·074	μ_2	R =	·015	$(M_2K_1)_3$	R =	·019
	ζ =		288°·85		ζ =	251°·88		ζ =	264°·95		ζ =	195°·07
	H =		·004		H =	·074		R =	·014		H =	·020
	κ =		78°·35		κ =	344°·40		κ =	104°·27		κ =	195°·41
M_4	R =		·033	J_1	R =	·007	R_2	R =	...	$(2M_2K_1)_3$	R =	·007
	ζ =		257°·03		ζ =	325°·84		ζ =	...		ζ =	37°·57
	H =		·031		H =	·008		H =	...		H =	·007
	κ =		96°·36		κ =	355°·74		κ =	...		κ =	336°·23

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·053	219° 65	0·048	352°·42
„ Fortnightly „	0·054	116 ·66	0·073	351 ·26
Luni-Solar „	0·044	114 ·78	0·043	15 ·11
Solar Annual „	0·364	230 ·49	0·364	227 ·97
„ Semi-Annual „	0·377	125 ·90	0·377	120 ·86

VALUES OF THE TIDAL CONSTANTS, MADRAS, 1885-86.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1885-86 observations at Madras; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1885-86 observations. The value of the amplitudes R and H are expressed in terms of British feet :—

Short Period Tides.

$A_0 = 2{\cdot}051$ feet.

S_1	H=	R =	·017	M_6	R =	·007	Q_1	R =	·008	T_2	R =	·080
	κ =	ζ =	75°·22		ζ =	307°·45		ζ =	53°·13		ζ =	255°·35
S_2	H=	R =	·415		H =	·006		H =	·009		H =	·080
	κ =	ζ =	289°·92		κ =	203°·94		κ =	96°·33		κ =	224°·68
S_4	H=	R =	·003	M_8	R =	·004	L_2	R =	·047	$(MS)_4$	R =	·011
	κ =	ζ =	287°·75		ζ =	330°·02		ζ =	87°·41		ζ =	304°·48
S_6	H=	R =	·001		H =	·003		H =	·040		H =	·010
	κ =	ζ =	66°·04		κ =	192°·00		κ =	298°·72		κ =	269°·98
S_8	H=	R =	·001	O_1	R =	·072	N_2	R =	·200	$(2SM)_2$	R =	·009
	κ =	ζ =	50°·19		ζ =	228°·35		ζ =	345°·96		ζ =	201°·57
					H =	·089		H =	·193		H =	·009
					κ =	332°·80		κ =	250°·21		κ =	236°·08
M_1	R =		·017	K_1	R =	·252	λ_2	R =	·012	$2N_2$	R =	·034
	ζ =		73°·77		ζ =	124°·27		ζ =	103°·81		ζ =	84°·82
	H =		·018		H =	·286		H =	·012		H =	0·32
	κ =		268°·91		κ =	345°·82		κ =	222°·48		κ =	287°·81
M_2	R =		1·021	K_2	R =	·088	ν_2	R =	·052	$(M_2N)_4$	R =	·023
	ζ =		293°·05		ζ =	42°·16		ζ =	185°·11		ζ =	231°·14
	H =		·983		H =	·118		H =	·050		H =	·021
	κ =		258°·54		κ =	305°·28		κ =	177°·44		κ =	100°·87

Short Period Tides—contd.

$A_0 = 2{\cdot}051$ feet.

M_3	R =	·003	P_1	R =	·090	μ_2	R =	·068	$(M_2K_1)_3$	R =	·009
	ζ =	231°·34		ζ =	209°·81		ζ =	239°·04		ζ =	258°·44
	H =	·003		H =	·090		H =	·063		H =	·010
	κ =	359°·58		κ =	348°·17		κ =	170°·03		κ =	85°·49
M_4	R =	·015	J_1	R =	·005	R_2	R =	·053	$(2M_2K_1)_3$	R =	·007
	ζ =	294°·21		ζ =	40°·97		ζ =	294°·98		ζ =	33°·44
	H =	·014		H =	·006		H =	·053		H =	·007
	κ =	225°·26		κ =	323°·27		κ =	145°·65		κ =	102°·88

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·063	274°·44	0·056	335°·70
„ Fortnightly „	0·034	46·79	0·054	343·37
Luni-Solar „ „	0·036	299·61	0·035	334·12
Solar Annual „	0·351	276·20	0·351	227·84
„ Semi-Annual „	0·281	236·81	0·289	140·09

Values of the Tidal Constants, Cocanada, 1887-88.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1887-88 observations at Cocanada; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1887-88 observations. The values of the amplitudes R and H are expressed in terms of British feet :—

Short Period Tides.

$A_0 = 5{\cdot}212$ feet.

S_1	H =	R =	·037	M_6	R =	·018	Q_1	R =	·007	T_2	R =	·064
	κ =	ζ =	77°·05		ζ =	246°·00		ζ =	13°·65		ζ =	20°·92
S_2	H =	R =	·628		H =	·016		H =	·008		H =	·064
	κ =	ζ =	285°·83		κ =	100°·84		κ =	20°·99		κ =	293°·60
S_4	H =	R =	·007	M_8	R =	·003	L_2	R =	·067	$(MS)_4$	R =	·023
	κ =	ζ =	146°·54		ζ =	248°·20		ζ =	310°·05		ζ =	313°·36
S_6	H =	R =	·004		H =	·002		H =	·082		H =	·023
	κ =	ζ =	159°·62		κ =	294°·65		κ =	235°·22		κ =	144°·98
S_8	H =	R =	·003	O_1	R =	·120	N_2	R =	·335	$(2SM)_2$	R =	·018
	κ =	ζ =	83°·09		ζ =	48°·63		ζ =	326°·84		ζ =	12°·88
					H =	·137		H =	·326		H =	·018
					κ =	332°·37		κ =	242°·06		κ =	181°·26
M_1	R =		·039	K_1	R =	·325	λ_2	R =	…	$2N_2$	R =	·062
	ζ =		332°·65		ζ =	66°·75		ζ =	…		ζ =	231°·27
	H =		·023		H =	·352		H =	…		H =	·060
	κ =		341°·58		κ =	338°·20		κ =	…		κ =	230°·09
M_2	R =		1·587	K_2	R =	·138	ν_2	R =	·018	$(M_2N)_4$	R =	·043
	ζ =		60°·82		ζ =	279°·79		ζ =	1°·59		ζ =	28°·00
	H =		1·545		H =	·169		H =	·018		H =	·041
	κ =		252°·43		κ =	283°·50		κ =	302°·68		κ =	134°·83
M_3	R =		·010	P_1	R =	·089	μ_2	R =	·034	$(M_2K_1)_3$	R =	·022
	ζ =		272°·46		ζ =	261°·43		ζ =	240°·78		ζ =	273°·41
	H =		·009		H =	·089		H =	·032		H =	·024
	κ =		19°·88		κ =	343°·11		κ =	264°·01		κ =	16°·47
M_4	R =		·029	J_1	R =	·032	R_2	R =	…	$(2M_2K_1)_3$	R =	·010
	ζ =		82°·72		ζ =	151°·99		ζ =	…		ζ =	206°·04
	H =		·027		H =	·036		H =	…		H =	·010
	κ =		105°·95		κ =	336°·26		κ =	…		κ =	317°·82

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·083	13°·90	0·076	290°·30
„ Fortnightly „	0·071	32·34	0·095	196·47
Luni-Solar „	0·024	316·68	0·023	125·06
Solar Annual „	0·671	190·95	0·671	199·26
„ Semi Annual „	0·522	82·13	0·522	98·77

Values of the Tidal Constants, Chittagong, 1887-88.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1887-88 observations at Chittagong; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1887-88 observations. The values of the amplitudes R and H are expressed in terms of British feet:—

Short Period Tides.

$A_0 = 7'945$ feet.

S_1	H =	·056	M_6	R =	·161	Q_1	R =	·022	T_2	R =	·139
	κ = ζ =	126°·75		ζ =	191°·88		ζ =	44°·82		ζ =	39°·65
S_2	H =	1·553		H =	·149		H =	·025		H =	·139
	κ = ζ =	68°·18		κ =	187°·69		κ =	358°·65		κ =	246°·33
S_4	H =	·053	M_8	R =	·038	L_2	R =	·331	$(MS)_4$	R =	·353
	κ = ζ =	62°·52		ζ =	117°·23		ζ =	155°·07		ζ =	25°·25
S_6	H =	·010		H =	·034		H =	·399		H =	·344
	κ = ζ =	125°·19		κ =	111°·64		κ =	39°·17		κ =	23°·85
S_8	H =	·002	O_1	R =	·256	N_2	R =	·863	$(2SM)_2$	R =	·142
	κ = ζ =	146°·98		ζ =	350°·89		ζ =	97°·57		ζ =	301°·65
				H =	·289		H =	·841		H =	·138
				κ =	16°·13		κ =	24°·78		κ =	303°·05
M_1	R =	·038	K_1	R =	·535	λ_2	R =	...	$2N_2$	R =	·082
	ζ =	130°·83		ζ =	43°·22		ζ =	...		ζ =	78°·69
	H =	·022		H =	·576		H =	...		H =	·080
	κ =	46°·83		κ =	20°·30		κ =	...		κ =	294°·49
M_2	R =	4·553	K_2	R =	·329	ν_2	R =	·303	$(M_2N)_4$	R =	·093
	ζ =	36°·69		ζ =	290°·97		ζ =	291°·50		ζ =	349°·19
	H =	4·440		H =	·397		H =	·295		H =	·088
	κ =	35°·29		κ =	65°·93		κ =	1°·67		κ =	274°·99
M_3	R =	·046	P_1	R =	·195	μ_2	R =	·291	$(M_2K_1)_3$	R =	·097
	ζ =	20°·44		ζ =	15°·54		ζ =	208°·39		ζ =	1°·82
	H =	·044		H =	·195		H =	·276		H =	·102
	κ =	198°·34		κ =	31°·21		κ =	205°·60		κ =	337°·51
M_4	R =	·415	J_1	R =	·025	R_2	R =	...	$(2M_2K_1)_3$	R =	·042
	ζ =	346°·31		ζ =	54°·11		ζ =	...		ζ =	242°·81
	H =	·395		H =	·027		H =	...		H =	·043
	κ =	343°·52		κ =	98°·88		κ =	...		κ =	262° 93

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	0·193	297°·23	0·177	8°·64
„ Fortnightly „ . . .	0·132	215·31	0·173	343·44
Luni-Solar „ . . .	0·471	40·92	0·459	42·31
Solar Annual „ . . .	1·435	57·41	1·435	131·74
„ Semi-Annual „ . . .	0·105	284·19	0·105	72·85

Values of the Tidal Constants, Akyab, 1887-88.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1887-88 observations at Akyab; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1887-88 observations. The values of the amplitudes R and H are expressed in terms of British feet :—

Short Period Tides.

$A_0 = 7{\cdot}486$ feet.

S_1	H = R =	·042	M_6	R =	·025	Q_1	R =	·002	T_2	R =	...
	κ = ζ =	84°·17		ζ =	248°·20		ζ =	219°·09		ζ =	...
S_2	H = R =	1·118		H =	·023		H =	·002		H =	...
	κ = ζ =	310°·28		κ =	132°·41		κ =	168°·98		κ =	...
S_4	H = R =	·006	M_8	R =	·006	L_2	R =	·085	$(MS)_4$	R =	·013
	κ = ζ =	208°·77		ζ =	297°·05		ζ =	88°·98		ζ =	351°·80
S_6	H = R =	·003		H =	·006		H =	·103		H =	·012
	κ = ζ =	107°·10		κ =	142°·66		κ =	291°·27		κ =	313°·20
S_8	H = R =	·003	O_1	R =	·161	N_2	R =	·533	$(2SM)_2$	R =	·042
	κ = ζ =	113°·43		ζ =	323°·01		ζ =	14°·93		ζ =	159°·32
				H =	·183		H =	·520		H =	·041
				κ =	338°·44		κ =	270°·79		κ =	197°·91
M_1	R =	·027	K_1	R =	·410	λ_2	R =	...	$2N_2$	R =	·054
	ζ =	86°·17		ζ =	34°·60		ζ =	...		ζ =	59°·96
	H =	·016		H =	·443		H =	...		H =	·052
	κ =	342°·06		κ =	344°·23		κ =	...		κ =	250°·28
M_2	R =	2·607	K_2	R =	·261	ν_2	R =	·055	$(M_2N)_4$	R =	·108
	ζ =	318°·72		ζ =	224°·34		ζ =	212°·28		ζ =	248°·93
	H =	2·540		H =	·317		H =	·053		H =	·102
	κ =	280°·12		κ =	304°·41		κ =	202°·15		κ =	106°·20
M_3	R =	·021	P_1	R =	·141	μ_2	R =	·018	$(M_2K_1)_3$	R =	·015
	ζ =	249°·21		ζ =	303°·77		ζ =	302°·62		ζ =	308°·91
	H =	·020		H =	·141		H =	·017		H =	·016
	κ =	11°·31		κ =	347°·04		κ =	225°·42		κ =	219°·94
M_4	R =	·006	J_1	R =	·019	R	R =	...	$(2M_2K_1)_3$	R =	·012
	ζ =	7°·00		ζ =	349°·36		ζ =	...		ζ =	54°·41
	H =	·006		H =	·021		H =	...		H =	·012
	κ =	289°·81		κ =	0°·88		κ =	...		κ =	27°·57

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·028	218°·27	0·026	283°·81
„ Fortnightly „	0·061	178 ·86	0·081	288 ·91
Luni-Solar „ „	0·047	18 ·96	0·046	57 ·56
Solar Annual „	0·950	99 ·07	0·950	145 ·80
„ Semi-Annual „	0·252	35 ·27	0·252	128 ·72

Values of the Tidal Constants, Elephant Point, 1886.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1886 observations at Elephant Point; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1886 observations. The values of the amplitudes R and H are expressed in terms of British feet :—

Short Period Tides.

$A_0 = 11{\cdot}997$ feet.

S_1	H = R =	·082	M_6	R =	·266	Q_1	R =	·003	T_2	R =	...
	κ = ζ =	128°·12		ζ =	30°·15		ζ =	106°·70		ζ =	...
S_2	H = R =	2·365		H =	·239		H =	·004		H =	...
	κ = ζ =	140°·19		κ =	337°·71		κ =	279°·48		κ =	...
S_4	H = R =	·078	M_8	R =	·120	L_2	R =	·414	$(MS)_4$	R =	·302
	κ = ζ =	173°·82		ζ =	284°·92		ζ =	102°·70		ζ =	23°·25
S_6	H = R =	·010		H =	·104		H =	·412		H =	·292
	κ = ζ =	296°·31		κ =	335°·01		κ =	138°·95		κ =	125°·77

Short Period Tides—contd.

$A_0 = 11{\cdot}997$ feet.

S_8	H=	R =	·002	O_1	R =	·265	N_2	R =	1·186	$(2SM)_2$	R =	·136
	κ =	ζ =	340°·02		ζ =	89°·72		ζ =	88°·14		ζ =	137°·81
					H =	·323		H =	1·145		H =	·131
					κ =	6°·88		κ =	86°·28		κ =	35°·28
M_1	R =		·020	K_1	R =	·669	λ_2	R =	...	$2N_2$	R =	·105
	ζ =		296°·06		ζ =	192°·09		ζ =	...		ζ =	249°·97
	H =		·015		H =	·751		H =	...		H =	·102
	κ =		54°·77		κ =	19°·40		κ =	...		κ =	143°·73
M_2	R =		6·107	K_2	R =	·449	ν_2	R =	·358	$(M_2N)_4$	R =	·135
	ζ =		0°·90		ζ =	300°·61		ζ =	172°·64		ζ =	295°·65
	H =		5·897		H =	·589		H =	·346		H =	·126
	κ =		103°·42		κ =	135°·87		κ =	122°·77		κ =	36°·31
M_3	R =		·029	P_1	R =	·195	μ_2	R =	·367	$(M_2K_1)_3$	R =	·124
	ζ =		169°·01		ζ =	226°·38		ζ =	83°·39		ζ =	73°·38
	H =		·027		H =	·195		H =	·342		H =	·134
	κ =		322°·80		κ =	35°·58		κ =	288°·44		κ =	3°·22
M_4	R =		·295	J_1	R =	·009	R_2	R =	...	$(2M_2K_1)_3$	R =	·066
	ζ =		245°·69		ζ =	176°·96		ζ =	...		ζ =	335°·82
	H =		·275		H =	·011		H =	...		H =	·069
	κ =		90°·74		κ =	106°·70		κ =	...		κ =	353°·55

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·084	255°·22	0·075	359°·60
„ Fortnightly „	0·096	284·42	0·148	12·62
Luni-Solar „ „	0·206	129·74	0·199	27·22
Solar Annual „	0·918	231·44	0·918	152·24
„ Semi-Annual „	0·141	280 34	0·141	121·94

VALUES OF THE TIDAL CONSTANTS, ELEPHANT POINT, 1887.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1887 observations at Elephant Point; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1887 observations. The values of the amplitudes R and H are expressed in terms of British feet :—

Short Period Tides.

$A_0 = 11{\cdot}982$ feet.

S_1	H=	R =	·075	M_6	R =	·264	Q_1	R =	·025	T_2	R =	·142
	κ =	ζ =	114°·21		ζ =	84°·26		ζ =	175°·46		ζ =	184°·42
S_2	H=	R =	2·366		H =	·242		H =	·030		H =	·142
	κ =	ζ =	139°·80		κ =	332°·21		κ =	4°·11		κ =	184°·87
S_4	H=	R =	·081	M_8	R =	·117	L_2	R =	·369	$(MS)_4$	R =	·285
	κ =	ζ =	176°·25		ζ =	235°·29		ζ =	268°·79		ζ =	286°·43
S_6	H=	R =	·011		H =	·104		H =	·448		H =	·277
	κ =	ζ =	272°·14		κ =	325°·89		κ =	125°·85		κ =	129°·08
S_8	H=	R =	·003	O_1	R =	·270	N_2	R =	1·242	$(2SM)_2$	R =	·138
	κ =	ζ =	38°·05		ζ =	343°·10		ζ =	78°·18		ζ =	241°·84
					H =	·313		H =	1·207		H =	·134
					κ =	4°·84		κ =	87°·73		κ =	39°·19
M_1	R =		·066	K_1	R =	6·97	λ_2	R =	...	$2N_2$	R =	·109
	ζ =		54°·53		ζ =	193°·42		ζ =	...		ζ =	150°·09
	H =		·039		H =	·761		H =	...		H =	·105
	κ =		64°·38		κ =	17°·66		κ =	...		κ =	326°·54
M_2	R =		6·081	K_2	R =	·570	ν_2	R =	·428	$(M_2N)_4$	R =	·211
	ζ =		260°·79		ζ =	315°·12		ζ =	215°·21		ζ =	227°·58
	H =		5·907		H =	·710		H =	·416		H =	·199
	κ =		103°·44		κ =	144°·43		κ =	94°·95		κ =	79°·77
M_3	R =		·042	P_1	R =	·223	μ_2	R =	·348	$(M_2K_1)_3$	R =	·143
	ζ =		181°·26		ζ =	221°·42		ζ =	257°·98		ζ =	9°·23
	H =		·040		H =	·223		H =	·329		H =	·151
	κ =		305°·24		κ =	30°·86		κ =	302°·38		κ =	36°·12

Short Period Tides—contd.

$A_0 = 11{\cdot}982$ feet.

M_4 R =	·307	J_1 R =	·022	R_2 R =	...	$(2M_2K_1)_3$ R =	·071
M_4 ζ =	45°·12	J_1 ζ =	47°·00	R_2 ζ =	...	$(2M_2K_1)_3$ ζ =	136°·05
M_4 H =	·290	J_1 H =	·025	R_2 H =	...	$(2M_2K_1)_3$ H =	·073
M_4 κ =	90°·42	J_1 κ =	61°·00	R_2 κ =	...	$(2M_2K_1)_3$ κ =	357°·12

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·062	154°·35	0·056	347°·45
„ Fortnightly „	0·032	128·40	0·044	107·55
Luni-Solar „	0·227	239·90	0·221	37·25
Solar Annual „	0·764	220·64	0·764	141·20
„ Semi-Annual „	0·150	247·80	0·150	88·91

Values of the Tidal Constants, Elephant Point, 1887-88.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1887-88 observations at Elephant Point; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1887-88 observations. The values of the amplitudes R and H are expresed in terms of British feet:—

Short Period Tides.

$A_0 = 11{\cdot}903$ feet.

S_1 H =	·101	M_6 R =	·265	Q_1 R =	·025	T_2 R =	...
S_1 κ =	111°·90	M_6 ζ =	55°·78	Q_1 ζ =	315°·00	T_2 ζ =	...
S_2 H =	2·395	M_6 H =	·246	Q_1 H =	·029	T_2 H =	...
S_2 κ =	140°·16	M_6 κ =	333°·61	Q_1 κ =	38°·76	T_2 κ =	...
S_4 H =	·081	M_8 R =	·114	L_2 R =	·352	$(MS)_4$ R =	·288
S_4 κ =	173°·22	M_8 ζ =	192°·33	L_2 ζ =	304°·14	$(MS)_4$ ζ =	277°·96
S_6 H =	·008	M_8 H =	·104	L_2 K =	·423	$(MS)_4$ H =	·281
S_6 κ =	258°·29	M_8 κ =	322°·78	L_2 κ =	120°·21	$(MS)_4$ κ =	130° 57
S_8 H =	·001	O_1 R =	·276	N_2 R =	1·218	$(2SM)_2$ R =	·141
S_8 κ =	63°·44	O_1 ζ =	132°·40	N_2 ζ =	27°·72	$(2SM)_2$ ζ =	253°·01
		O_1 H =	·312	N_2 H =	1·188	$(2SM)_2$ H =	·138
		O_1 κ =	5°·79	N_2 κ =	90°·70	$(2SM)_2$ κ =	40°·39
M_1 R =	·065	K_1 R =	·707	λ_2 R =	...	$2N_2$ R =	·202
M_1 ζ =	229°·43	K_1 ζ =	35°·32	λ_2 ζ =	...	$2N_2$ ζ =	100°·39
M_1 H =	·038	K_1 H =	·760	λ_2 H =	...	$2N_2$ H =	·197
M_1 κ =	72°·76	K_1 κ =	18°·28	λ_2 κ =	...	$2N_2$ κ =	13°·74
M_2 R =	6·092	K_2 R =	·632	ν_2 R =	·321	$(M_2N)_4$ R =	·206
M_2 ζ =	251°·53	K_2 ζ =	0°·55	ν_2 ζ =	210°·20	$(M_2N)_4$ ζ =	220°·51
M_2 H =	5·941	K_2 H =	·763	ν_2 H =	·313	$(M_2N)_4$ H =	·196
M_2 κ =	104°·14	K_2 κ =	147°·24	ν_2 κ =	66°·62	$(M_2N)_4$ κ =	136°·10
M_3 R =	·033	P_1 R =	·195	μ_2 R =	·401	$(M_2K_1)_3$ R =	·045
M_3 ζ =	327°·36	P_1 ζ =	23°·06	μ_2 ζ =	236°·90	$(M_2K_1)_3$ ζ =	211°·42
M_3 H =	·031	P_1 H =	·195	μ_2 H =	·382	$(M_2K_1)_3$ H =	·047
M_3 κ =	286°·28	P_1 κ =	32°·83	μ_2 κ =	302°·13	$(M_2K_1)_3$ κ =	46°·99
M_4 R =	·295	J_1 R =	·021	R_2 R =	...	$(2M_2K_1)_3$ R =	·031
M_4 ζ =	26°·22	J_1 ζ =	320°·48	R_2 ζ =	...	$(2M_2K_1)_3$ ζ =	267°·55
M_4 H =	2·80	J_1 H =	·023	R_2 H =	...	$(2M_2K_1)_3$ H =	·032
M_4 κ =	91°·44	J_1 κ =	89°·33	R_2 κ =	...	$(2M_2K_1)_3$ κ =	349°·82

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·116	201°·26	0·107	350°·89
„ Fortnightly „	0·028	94·50	0·037	20·33
Luni-Solar „	0·174	242·97	0·170	30·36
Solar Annual „	0·845	68·65	0·845	148·88
„ Semi-Annual „	0·115	313·12	0·115	113·58

Values of the Tidal Constants, Rangoon, 1885-86.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1885-86 observations at Rangoon; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1885-86 observations. The values of the amplitudes R and H are expressed in terms of British feet :—

Short Period Tides.

$A_0 = 10{\cdot}301$ feet.

S_1	H =	·106	M_6	R =	·255	Q_1	R =	·017	T_2	R =	·289
	κ = ζ =	139°·21		ζ =	80°·27		ζ =	350°·76		=	181°·97
S_2	H = R =	1·922		H =	·228		H =	·021		H =	·289
	κ = ζ =	171°·93		κ =	91°·81		κ =	39°·94		κ =	123°·75
S_4	H = R =	·083	M_8	R =	·105	L_2	R =	·326	$(MS)_4$	R =	·408
	κ = ζ =	261°·38		ζ =	93°·30		ζ =	235°·67		ζ =	213°·65
S_6	H = R =	·011		H =	·091		H =	·283		H =	·393
	κ = ζ =	47°·62		κ =	108°·69		κ =	131°·20		κ =	217°·50
S_8	H = R =	·005	O_1	R =	·228	N_2	R =	1·115	$(2SM)_2$	R =	·194
	κ = ζ =	133°·41		ζ =	276°·37		ζ =	180° 16		ζ =	59°·57
				H =	·283		H =	1·074		H =	·187
				κ =	32°·04		κ =	117°·51		κ =	55°·72
M_1	R =	·016	K_1	R =	·590	λ_2	R =	·237	$2N_2$	R =	·123
	ζ =	285°·07		ζ =	148°·21		ζ =	83°·67		ζ =	254°·39
	H =	·017		H =	·669		H =	·228		H =	·118
	κ =	143°·52		κ =	37°·18		κ =	197°·05		κ =	125°·24
M_2	R =	5·821	K_2	R =	·523	ν_2	R =	·472	$(M_2N)_4$	R =	·297
	ζ =	129°·29		ζ =	232°·00		ζ =	23°·24		ζ =	70°·08
	H =	5·609		H =	·699		H =	·455		H =	·275
	κ =	133°·13		κ =	189°·98		κ =	97°·55		κ =	11°·28
M_3	R =	·032	P_1	R =	·139	μ_2	R =	·609	$(M_2K_1)_3$	R =	·152
	ζ =	188°·86		ζ =	306°·33		ζ =	284°·40		ζ =	173°·61
	H =	·030		H =	·139		H =	·566		H =	·166
	κ =	14°·63		κ =	57°·14		κ =	292°·09		κ =	66°·43
M_4	R =	·437	J_1	R =	·027	R_2	R =	·112	$(2M_2K_1)_3$	R =	·115
	ζ =	167°·62		ζ =	180°·63		ζ =	167°·08		ζ =	290°·32
	H =	·405		H =	·033		H =	·112		H =	·121
	κ =	175°·31		κ =	135°·30		κ =	45°·30		κ =	49°·04

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·233	305°·24	0·206	11°·74
„ Fortnightly „	0·107	84·70	0·1 1	37·21
Luni-Solar „ „	0·562	54·74	0·542	50·89
Solar Annual „	1·184	171·24	1·184	150·43
„ Semi-Annual „	0·228	339·89	0·228	298·27

Values of the Tidal Constants, Port Blair, 1885-86.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1885-86 observations at Port Blair; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1885-86 observations. The values of the amplitudes R and H are expressed in terms of British feet :—

Short Period Tides.

$A_0 = 4{\cdot}612$ feet.

S_1	H = R =	·006	M_6	R =	·009	Q_1	R =	·016	T_2	R =	·112
	κ = ζ =	124°·99		ζ =	206°·24		ζ =	284°·12		ζ =	37°·27
S_2	H = R =	·933		H =	·008		H =	·020		H =	·112
	κ = ζ =	321°·75		κ =	232°·71		κ =	250°·40		κ =	290°·74
S_4	H = R =	·004	M_8	R =	·003	L_2	R =	·099	$(MS)_4$	R =	·006
	κ = ζ =	67°·89		ζ =	140°·53		ζ =	228°·99		ζ =	284°·50
S_6	H = R =	·002		H =	·002		H =	·087		H =	·006
	κ = ζ =	99°·46		κ =	55°·82		κ =	290° 85		κ =	173°·32

Short Period Tides—contd.

$A_0 = 4{\cdot}612$ feet.

S_8	H = R	·002	O_1	R	·131	N_2	R	·405	$(2SM)_2$	R	·022
	κ = ζ	113°·63		ζ	351°·20		ζ	15°·03		ζ	70°·49
				H	·162		H	·391		H	·021
				κ	304°·28		κ	277°·04		κ	181°·67
M_1	R	·032	K_1	R	·350	λ_2	R	...	$2N_2$	R	·068
	ζ	327°·05		ζ	35°·44		ζ	...		ζ	324°·73
	H	·032		H	·397		H	...		H	·066
	κ	314°·58		κ	332°·29		κ	...		κ	239°·95
M_2	R	2°·025	K_2	R	·174	ν_2	R	·145	$(M_2N)_4$	R	·025
	ζ	36°·37		ζ	267°·80		ζ	156°·59		ζ	332°·91
	H	1·951		H	·233		H	·139		H	·024
	κ	285°·19		κ	321°·64		κ	281°·26		κ	123°·75
M_3	R	·004	P_1	R	·129	μ_2	R	·076	(M_2K_{13})	R	·023
	ζ	207°·90		ζ	264°·96		ζ	174°·80		ζ	328°·78
	H	·004		H	·129		H	·071		H	·025
	κ	41°·13		κ	327°·47		κ	312°·44		κ	154°·45
M_4	R	·018	J_1	R	·027	R_2	R	...	$(2M_2K_1)_3$	R	·005
	ζ	330°·51		ζ	64°·98		ζ	...		ζ	58°·82
	H	·016		H	·032		H	...		H	·005
	κ	108°·16		κ	347°·53		κ	...		κ	259°·61

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·038	354°·06	0·034	340°·86
„ Fortnightly „	0·030	229·50	0·048	32·17
Luni-Solar „ „	0·087	243·27	0·036	354·44
Solar Annual „	0·255	119·05	0·255	146·54
„ Semi-Annual „	0·201	125·82	0·201	180·82

Values of the Tidal Constants, Port Blair, 1886-87.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1886-87 observations at Port Blair; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1886-87 observations. The values of the amplitudes R and H are expressed in terms of British feet :—

Short Period Tides.

$A_0 = 4{\cdot}506$ feet.

S_1	H = R	·024	M_6	R	·007	Q_1	R	·012	T_2	R	...
	κ = ζ	79°·12		ζ	223°·70		ζ	230°·95		ζ	...
S_2	H = R	·953		H	·006		H	·014		H	...
	κ = ζ	316°·73		κ	190°·35		κ	213°·89		κ	...
S_4	H = R	·002	M_8	R	·002	L_2	R	·078	$(MS)_4$	R	·003
	κ = ζ	256°·76		ζ	139°·40		ζ	15°·39		ζ	356°·42
S_6	H = R	·003		H	·002		H	·083		H	·003
	κ = ζ	117°·55		κ	94°·94		κ	268°·61		κ	345°·31
S_8	H = R	·002	O_1	R	·126	N_2	H	·419	$(2SM)_2$	R	·031
	κ = ζ	49°·76		ζ	243°·17		ζ	359°·16		ζ	134°·74
				H	·152		H	·405		H	030
				κ	301°·63		κ	272°·52		κ	145°·85
M_1	R	·026	K_1	R	·356	λ_2	R	...	$2N_2$	R	·072
	ζ	72°·54		ζ	35°·64		ζ	...		ζ	84°·27
	H	·017		H	·397		H	...		H	·070
	κ	321°·50		κ	328°·49		κ	...		κ	282°·10
M_2	R	2·054	K_2	R	·180	ν_2	R	·104	$(M_2N)_4$	R	·083
	ζ	291°·99		ζ	265°·04		ζ	178°·44		ζ	236°·17
	H	1·986		H	·234		H	·100		H	·078
	κ	280°·88		κ	311°·48		κ	232°·64		κ	138°·41

Short Period Tides—contd.

$A_0 = 4{\cdot}506$ feet.

M_8	R =	·008	P_1	R =	·131	μ_2	R =	·086	$(M_2K_1)_3$	R =	·019
	ζ =	210°·70		ζ =	263°·10		ζ =	307°·69		ζ =	312°·85
	H =	·007		H =	·131		H =	·080		H =	·021
	κ =	14°·03		κ =	325°·84		κ =	285°·46		κ =	234°·58
M_4	R =	·009	J_1	R =	·012	R_2	R =	...	$(2M_2K_1)_3$	R =	·005
	ζ =	98°·33		ζ =	323°·87		ζ =	...		ζ =	219°·47
	H =	·008		H =	·015		H =	...		H =	·005
	κ =	76°·09		κ =	329°·82		κ =	...		κ =	264°·40

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·026	294°·01	0·023	9°·53
„ Fortnightly „	0·017	242·39	0·025	294·35
Luni-Solar „ „	0·028	62·39	0·027	73·51
Solar Annual „	0·048	97·60	0·048	124·85
„ Semi-Annual „	0·105	182·04	9·105	236·55

UPPER BURMA.

Report on the Survey Operations in the SOUTHERN SHAN STATES *by* CAPTAIN H. M. JACKSON, R.E., *Season 1887-88.*

Starting from Mandalay, I reached Fort Stedman, the *rendezvous* of the "Southern Shan Column," which I had been detailed to accompany for survey work, on the 19th of November, having observed *en route* from one station on the Pwehla plateau for the southern extension of the triangulation. My party consisted of two sub-surveyors of the Survey Department and two military surveyors of the Corps of Guides. Of these, I soon found that only one sub-surveyor and one of the "Guides" surveyors could be depended upon for any reliable work. These two, Sub-Surveyor Ali Nawaz and Duffadar Jowala Singh, both turned out excellent workmen.

On arrival at Fort Stedman, I found that I had very little time to spend on preliminaries. I had intended to measure a base of verification in the Inlè valley in which Fort Stedman is situated; but this was out of the question. One day was taken up in transport and commissariat arrangements and in setting the plane-table compasses at the nearest triangulation station; and on the next I started across to the other side of the southern end of the Inlè lake and ascended and observed from the "Piyakalà" hill pagoda, about 2,000 feet above the lake. Returning the following day, I overtook the column at nightfall at its first camp southwards. From a station of my triangulation near this, I started one sub-surveyor and one military surveyor on plane-table work and compass traverse respectively. These men carried on this work continuously with the main body of the column, which made straight southwards down the left bank of the Paungdaw or Balu-Kyaung to Pèkôn. At the third halting place, a detachment of cavalry and mounted infantry was sent westwards across the river to make a detour through the hilly country known generally as Lwèlôn or Loilôn. This I accompanied, as affording better chances for triangulation, and took with me the other sub-surveyor and the other military surveyor. The progress of the column was so rapid, however, that to carry on the triangulation was no easy task. The States of Loilôn, Thigyit, Loi-è, and Pinlaung occupy the southern end of the Myelat plateau, where it first begins to break up into irregular hill masses. The general elevation of this country is about 4,000 feet above the sea; Pinlaung, 4,670 feet, the principal town of these States, being about the highest place in the part we traversed. The climate here in November was pleasant enough, the maximum temperature during the day being about 70° and the minimum 40°. The dense white mist, however, which in the mornings envelopes everything at this time of the year, is rather disagreeable. The people are of very mixed race, the Karen strain shewing itself distinctly in their speech and features. The dry hill cultivation is carried on by the Taungzus and Padaungs (Karens); the wet valley cultivation by the Shans, as in other parts of the

States. They are a rough but apparently kindly, easy-going people, and seem fairly well off, the nature and position of their country saving them, doubtless, from many of the raids from which their neighbours of the valleys suffer.

At Pinlaung, which lies to the west of the Inlè lake, we halted a day. It is a straggling village of by no means flourishing aspect, lying in a sheltered valley, and apparently it is not healthy, as about a third of our force was down with fever before we left. The trees in this part of the country are mostly hill-oak, but pines occur in patches here and there, particularly in the more open valleys. Generally speaking, all through the Shan country there are two sorts of pine—one two-leaved, the other three-leaved—both to the casual observer very like the *chir* of Northern India. From Pinlaung one descends gradually to Kangyi Myo, where the Mobyè Tsawbwa usually lives, cultivating his own fields in a good, old-fashioned way. From this the descent is rapid to Pèkôn, which is about 1,500 feet lower (*i.e.*, about 2,650 feet above sea-level). I was so unfortunate as to contract fever from exposure to the cold of the nights before I could satisfactorily complete the triangulation to this place; and on arrival there, I was so completely laid up that I was obliged to be carried the next five marches in a dooly. This was particularly unfortunate, as it was very desirable to measure a base-line near Pèkôn in the flat rice-fields of the valley, which was well adapted for this purpose. I made the attempt, but the result only increased my fever, without any success. Here, at Pèkôn, our detachment and the main body met, and we all halted three days. Our stay was too uncertain, however, until almost the last moment to enable any exploration southwards to be ventured on.

Pékôn is now practically the chief town of the State of Mobyé and a place of some general importance, though unhealthy. A good bridge connects the town on the right bank with the old Burmese fort on the left bank of the Mobyé river, here so called, *alias* the Balukyaung or Paungdaw. During our stay at this place the average maximum temperature was 80°, the minimum 55°. Here one is close to the frontier of the Karen country; and there are many outlying Padaung villages round. The women of this tribe are the victims of a curiously cruel fashion, which compels them from childhood to wear a collar formed of spiral coils of brass, which are gradually enlarged as the child grows, so that the neck is kept always stiffly stretched. At the back of the collar is a handle, also of brass, the use of which may be imagined.

The men of the Karen tribe are a dirty, uncouth lot, of poor physique and small size, but very tough and wiry; they are great hunters and great thieves. Their arms are light spears and long flint-locks like Afghan *jezails*. When on the prowl they always carry their provisions in the form of a long sausage of boiled rice tightly rolled up in dirty cloth *en bandoliére*, like a regimental greatcoat. The great Karen chief, Sawlapwa, refused to come in to do obeisance; but another smaller chief, Pawbia, visited the camp with his rabble. His manners were crude, and he seemed not at all impressed by our sample of the British power. From Pékôn we moved north-eastwards across the northern end of Sawlapwa's territory, and through the small States of Letmaing and Tabet, now absorbed in the larger State of Thaton, one of the chief villages of which, Si-saing (height about 3,000 feet), we reached on the 8th of December, having crossed the Tabet river by a bridge the day before. The country we passed through was mostly jungle and waste, much of it formerly having been under cultivation. We marched the whole of one day through grand pine forests. At Si-saing, I had sufficiently recovered to get about again, and from a hill pagoda, fairly near, managed to connect on to my triangulation of the season before. Thaton being in the same Tabet valley we had struck before at Hopôn during the previous expedition. From this we moved north to Loipôk, the other chief village of Thaton, and here I made good my connection. Thaton is a flourishing State, rather in the pastoral condition, the people owning large herds of cattle; for agriculture is at a discount owing to much fighting of recent years with border Karens and neighbours of Nyaungwé: tobacco, however, is grown in some quantity. The ruler is a Taungzu, and apparently one of the ablest of the chiefs, though he does not rank as a Tsawbwa. He has absorbed the smaller states of Letmaing and Tabet to the south, probably to their advantage, as, united, they are better able to check the Karens. From Loipôk our course was east to the ford over the Pôn river, which here runs between high hills on either side at a level of about 1,000 feet below Si-saing. The ford and the descent and ascent to and from it proved so difficult that it took a whole day to get our numerous transport animals across. Ascending from the Pôn river and proceeding eastwards, we crossed in two marches an undulating plateau of about 3,300 feet altitude, scantily cultivated; and in the third descended nearly 2,000 feet into the Maukmé valley, camping on its western edge. The next day, the 16th December, escorted by a miscellaneous and picturesque collection of warriors and a band of an extremely painful nature, the Tsawbwa led us slowly across the muddy rice-fields to the camp prepared for us near his capital.

Thaton.
Av. max. temp 78° } December.
„ min. „ 45° }

Av. max. temp. 75° } December.
„ min. „ 45° }

At all the chief places we halted at bamboo houses were built for us (and in some parts every camp was thus prepared), except when we got into Thibaw territory, the ruler of which, pampered by our Government, has become too big a man in his own estimation to condescend to take any such trouble.

Of Maukmè, I have written in my report of last year. I may mention, however, that we found the old king still unburied; and I believe it was only when, some time after we had left, a Karen raid caused the hurried departure of the court, that the old gentleman

was deposited in his last resting-place. We stayed at Maukmè three days, so that I was enabled to measure a base-line and to observe its azimuth in the level valley and to connect it with my triangulation. I had some difficulty in carrying this forward, however, as the hills enclosing the valley are very steep and thickly wooded to the top with eng and pine.

Maukmè. Height 1,128 feet.
Av. max. temp. 83° } December.
„ min. „ 49° }

On the 21st of December we left Maukmè, and continuing eastwards across the hills by a fairly easy pass, reached the Tein river at its junction with the Kalôn stream, in two marches. The country passed through was jungle-covered, until close to the river, where we passed a few largish villages, the largest being Banhàt. The Tein here runs between high banks; it is very deep and of a peculiar turquoise blue colour. The road is a track cut in the right bank just broad enough for pack animals,. We reached Tameungkè, where the principal ford is, in one march. Here is the great tobacco-growing country of the Shan States. The fields are irrigated by immense water-wheels, with bamboo dippers of very ingenious construction, such as were seen also on the Pôn river at Meinpôn. One day was taken up in crossing the river; so I went in advance with two days' provisions on coolies, to ascend one of the peaks of the Loi-salu, a high, short range, seemingly a spur of the northern plateau; for the Tein river turns sharply round the end of it on its way to the Salween. Sleeping one night at about 4,000 feet up, I reached the top the next day, which was Christmas Day, and was rewarded by one of the grandest views I have seen in this country. The peak is 5,754 feet high; the sides of the ridge are sheer rock, to be climbed only by means of overhanging creepers. Though obliged to descend by the same side, we managed to catch up the column the next day, and on the 28th December arrived at Maingpan, the capital of the State of that name. Maingpan was found in a very poor condition, as it had been lately burnt by a freebooter from the other side of the Salween, who was afterwards captured at Monè in the most plucky way by Mr. Scott, the Assistant Commisioner, and one of the officers of the 2nd Baluchis. The town is, however, very favourably situated in a broad stretch of flat ground, watered by the Nampan river and surrounded by hills, and no doubt, when property is more secure, it will become a flourishing place. Having started the sub-surveyors to work round as usual, I went up one of the near peaks which was observed to from the Loi-salu range, stayed one night in a village and got back to camp next day, when I started to ride to the Salween, so as to get a point on the course of that river by a rough traverse and bearings if possible. We reached the great boundary river by the bed of the Me-Sili stream, by aneroid 560 feet, on the morning of the second day. It here runs about 200 yards wide over a boulder-strewn sandy bed between steep, jungle-covered hills. In the rains it would be quite double this width. We had to ride straight back to Maingpan the same day, and got in by sunset, although the going was very bad, being mostly along rocky stream beds or under low hanging bamboos. A considerable ascent also (of about 2,000 feet) has to be made over the watershed of the Nampan river, which runs into the Tein.

At Maingpan, the British Resident at Chiengmai (Zimmè) came in to us with several Siamese officials, who were very friendly and thirsty, and left us full of promises and whisky. They had an immense following of Laos and others armed with weapons variously antique. The column left Maingpan on the 3rd of January, and returning by the same road reached Tameungkè on the 5th. The pass across the Loi-salu is very rough and steep in parts. From Tameungkè we went up north-west to Monè, reaching it in two marches, the first a very long up-hill one.

Maingpan.
Av. max. temp. 79° } December.
„ min. „ 46° }
Alt. 1,930 feet.

Monè was described by me in last year's report. The event of this our second visit was the great durbar, which was attended by all the chiefs from the hills and plains around except the extreme northern. This year I measured a check base-line as accurately as possible, and observed for azimuth and latitude and connected and extended the triangulation. I set one sub-surveyor, Ali Nawaz, on detail work round about; the other sub-surveyor, who had been ill since we left Loilôn, I sent back to Fort Stedman with a sick convoy. The military surveyors I sent with the Intelligence Officer, Lieutenant Stanton, R A., who having joined us at Monè made an expedition thence through the tributary State of Kyaing-taung to the Salween, and working round joined us on our forward course near Legya-myo.

They did some very good work on this, as on other reconnaissances, thanks to the energy of Lieutenant Stanton, to whom we are much indebted for all such outside work with this column, and also for much useful geographical information which he was most indefatigable in gleaning at every possible opportunity. From this I handed over the military surveyors to him entirely. Sub-surveyor Ali Nawaz carried on a chain traverse continuously with the column as before, and I carried on the triangulation and general plate-table sketching: thus we got as much work done as I think was under the circumstances possible. I started again two days ahead of the troops. Our course lay due north up the Namkai valley to Hepek, thence north-west to Legya. At Hepek I was left behind in spite of my start, as I had to go some distance to obtain satisfactory stations, and the column on this occasion made a 20-mile march by mistake. From Hepek northwards the road crosses into the valley of the Tein, on to the beginning of that river's first eastward bend after leaving its native hills. At this place coal is found at the surface, shewing in the river banks: it burns fairly well. Hence northwards one passes through a desolate region to Legya-myo.

Monè. Height 2,930 feet.
Av. max. temp. 74° } January.
„ min. „ 42° }
Min. „ 37°*
*Greatest cold experienced during tour.

The whole country round has been wasted by fire, sword, and famine. In the fields, in place of crops are the bones of men and beasts. Legya was, two years ago, one of the strongest States; but a combination of her neighbours crushed her, and famine having followed on defeat, her glory is departed. At Legya-myo, the chief "town," we stayed two days, and I was able to connect in a way my triangulation, which had become rather attenuated by long marches. From this place our course was generally north up to Maing-ngè (Maing-yè). Our next halt was at Maing-kaing, capital of the State of that name. It is on the Namtin (Tein) river, which here is a small stream running from south to north from its source in the Loi-sampa hills that wall in the valley. This is one of the highest ranges of the country. Unfortunately I had not time to ascend one of its peaks from which I might have done some very useful work.

Legya. Height 2,676 feet.
Av. temp. max. 74° } January.
„ „ min. 49° }

Maing-kaing is in rather better condition than Legya, but by no means flourishing. Its ruler is a boy of about twelve, whose authority speaks well for the sense of the "divine right" of kings amongst the Shans. There is some beautiful, undulating grass land round Maing-kaing, plenty of timber, pine and other; and, as we are here as nearly as possible in the middle of the States, one cannot help speculating on the possibility of this being a good place for a central post and colony from which our civilisation may radiate. The Shan would perhaps not improve by being civilised; but the country is too good to be wasted, as now most of it is. Leaving Maing-kaing on the 4th of February, we made north-north-east to Kyithi-bansam (*Shan* Kisi-mansam). Our first camp out was north of the first eastern turn of the Tein river, where it leaves the Maing-kaing valley; and here we parted from its friendly waters. After much up and down hill work, through more pine forest, we reached Kyithi-bansam on the 8th.

Maing-kaing. Height 2,968 feet.
Av. max. temp. 78° } February.
„ min. „ 41° }

Here the column stayed three days. It is a good sized village on the Nam-hong river, a large stream here running southwards, in which are numbers of a large black mahseer-shaped fish of the carp species, not before seen by any of us. They proved very good to eat. There is still a considerable Chinese settlement near the village, which was formerly a much larger one. From Kyithi-bansam Lieutenant Stanton took a reconnaisance survey to Maing-noung and the Ben river. Whilst we were at this place, the spring haze first set in, a dense smoke fog that renders triangulation a work of lamentation. In order to connect southwards satisfactorily, I had to make one march in this direction and camp. Before I could get back, the column had already got one march in advance. Orders, necessitated by the disturbed state of the country ahead, where the redoubtable Kun-Sain-Tôn-Hôn was still wavering between independence and allegiance, compelled a forced march of fourteen hours' going to overtake the troops. On the way we crossed at sunset the Namlaung, breast high at the ford. This large stream and the Nampwan, on which we found the column encamped the same night, flows south-west into the Namlung, which rises to the north of Maing-ngè in the Loi-lin hills. Two marches more brought us to Maing-ngè. Here we were to have been met by another column which had traversed the northern part of the States; but this meeting was counter-ordered, the northern column returning to Thibaw and Mandalay, leaving only the Political Officer of the Northern States and two other officers to join us at Maing-ngè. Sub-surveyor Faida Ali had accompanied the northern column and done some very good work with it; but, unfortunately, owing to some mistake or miscarriage of orders, he did not meet me, as was intended. At Maing-ngè the afore-mentioned chief, Kun-Sain-Tôn-Hôn, came in, tendered his allegiance, and was confirmed in his territory, or what he said was his. He was accompanied by a wondrous army of tatterdemalions, Kachins and Shans. The Kachins are much feared in these parts, as they go in for fighting seriously, and the Shans do not like their way of playing the game of war. Half-a-dozen Kachins will clear out any ordinary Shan village and have it all their own way.

Kyithi-bansam. Height 2,894 feet.
Av. max. temp. 75° } February.
„ min. „ 48° }

We stopped some time at Maing-ngè; but from the time we left Kyithi-bansam, the atmosphere had been getting thicker and thicker every day, so triangulation was almost impossible. I measured a base-line and observed for azimuth and brought up the triangulation, from which it was found afterwards on computation that I had closed exactly on two of Major Hobday's plane-table points brought west from Thibaw, thus proving roughly our whole work in these parts.

Maing-ngè. Height 2,397 feet.
Av. max. temp. 81° } Feb. & March.
„ min. „ 49° }

Having waited some time in vain for clear weather, I proceeded to make for the great peak of the Loi-lin range, the highest peak in the States. It lies only about 15 miles, as the crow flies, to the north of Maing-ngè, but the direct ascent on this side is difficult. We therefore went up from the west through some clearings and by a village of the Musus. At this village we slept the first night at about 3,000 feet altitude. The Musus are a peculiar race, said by some to be closely akin to the aboriginal races of China. They seem industrious clearers of jungle and tillers of the soil. Their houses are built somewhat like those of the Kachins, so as to hold several families, but are not so long: they keep many pigs and fowls. Their only arms, as far as we saw, are cross-bows with light bamboo darts tipped with poisoned barbs. These particular Musus were suffering severely from fever, and readily ate the quinine we gave them, I suppose on the principle of its being so nasty that it must be good medicine, for they could not possibly have tried it before. After some

difficulty, owing to the superstitions attaching to the hill, we persuaded some of these people to act as guides and coolies, and the next day got to a point just under the main ridge, at the last place where water was procurable. The next day, leaving our camp below the ridge, we reached the top (8,377 feet) and saw nothing, as a dense curtain of smoke covered the country. A rocky ridge, rising into many irregular tops covered with bamboo, oak and other trees, culminates in the main peak, which is bare to the west, but on all the other sides is clothed with rhododendron trees. These were in full flower when we were there and presented an extremely pretty sight. The soil of the peak shews signs of frost and snow; but we could not quite make sure from the natives whether there ever was actually snow on it, or only hoar-frost, the Burmese language, our medium of communication, not possessing clearly distinctive words for these phenomena. We reached camp again from the top about midnight, after some very rough going in the dark. Tracks of bison, tiger and rhinoceros were seen, and quantities of pig. From our camp under the ridge Lieutenant Stanton and I descended by the direct path down the south side, through the Maing-pat valley, and by going all day reached Maing-ngè the same night. All this south side and also the south-east side of the Loi-lin and the country round was surveyed in detail subsequently.

Maing-ngè (*Shan* Meung-ngai) is said to have been formerly one of the largest towns of the States; but this must have been some time ago. Now there is nothing left but a very small village having an ordinary weekly bazaar, which is fairly attended. Some *kyaungs* and pagodas however, and the remains of an extensive wall and moat now hidden in the jungle, certainly testify, as at Legya and Maing-kaing, to a former state of greater prosperity. A large lake used to lie near where our camp was. This, they say, was drained in order to get at the fish in a time of great scarcity resulting from continuous warfare. Maing-ngè is, no doubt, fairly well situated and probably, now things are more settled, will soon recover its previous condition. To the north of the hills bounding the Maing-ngè basin, and under the south-eastern slopes of the Loi-lin, there are many prosperous villages (of which the chief and nearest is Maing-pat) and much good rice-land.

Whilst the sub-surveyor worked in this direction, the two military surveyors were sent to get by traverse a point on the Ben-pin or Nam-pon river, one of the largest tributaries of the Salween in these parts. Information as to the distance, however, was incorrect, so that they did not succeed in reaching it, though it was possible from their work to locate it within a mile of its true position. On the 7th of March, I started ahead of the column by another route from that taken by the latter, leaving the sub-surveyor to accompany it as usual. I soon found that triangulation was out of the question, so I carried on an ordinary chain traverse along with the plane-table. After leaving Maing-ngè northwards one passes round the western slopes of the Loi-lin up the valley of the Nam-ma through many fairly large villages forming the *hein*-ship of Hoya. Thence, turning more westwards, the road leads through low hills, mostly jungle-covered, and with few villages. Near one of these, Nati, iron is found and smelted on a small scale. On the 9th March, I joined the column at Paseng, a largish village. Thence we struck north to Mansè on the Nammi river, which at that place is about 200 yards wide and swift, but shallow and easily fordable. Mansè is another almost deserted village, once having been a large place. From it I went up a peak of the Loi-pahtan, about 5,200 feet ascent, in the hopes of seeing some of my points behind, but the mist was too thick. In these hills I found the Shans of the lower villages still taking refuge from the Kachins. There are many Palaung villages up here which seem populous and well-to-do. Our next camp was at Lashio, which is another of those places, once famous, now hardly existing but in name. It is on the edge of a broad hill-girt plain, often, even up to recent times, the battle-field of Shans and Burmans. We stayed here one day, so I was enabled to cross the plain and the large Nam-yau stream and go up the Loi-ma to a peak I had observed to previously. The next day we marched to a ford-camp on the Nam-yau river, which we crossed. This river is here about 160 yards broad and, except at the ford, deep. From this camp I determined to make a final effort to connect on with the Loi-lin and carry through the triangulation to Thibaw; so I cut myself adrift from the column and started southwards down the Nam-yau valley, making for Loi-ûn, a conspicuous conical peak which I had observed to from the Loi-pahtan. We only succeeded in reaching a village underneath it that day, so (not having provided for sleeping out) had to ask the Shans for food and lodging. They, however, had nothing better to offer us than water-lily roots, but suggested that the Palaungs in a village higher up had rice, so there we went, and were well fed and housed in the village church, all the male inhabitants coming to examine and discuss us in turn. In the morning we went up the hill, and, as usual, saw nothing but smoke. Loi-ûn is evidently an old volcano of some sort. There is a distinct central crater (filled in with sand) of perfectly circular form, and there are also two smaller side "blow-holes." The rock appears to be lime and sandstone. In the cups is a deposit of a kind of soft pumice stone. The natives say that this "crater" is made by the deer rolling in the water that lies in it in the rains, and evidently have no tradition of any volcanic activity. The conical summit is quite bare of vegetation for about 100 feet. We got back to our camp at the Nam-yau ford next day, but were too tired to go on, finding that rice alone is not food that stands by any one used to other material. On the morrow we made a double march to Mansam, passing by a rough up and down road through a few Kachin villages, which

Lashio. Height about 2,350.
Av. max. temp. 84° } March.
„ min. „ 56° }

consist for the most part of one long hut slightly raised on piles, a kind of barrack in which many families live, separated or not by bamboo partitions. Mansam is a large village with a good-sized permanent bazaar. It is important as a *rendezvous* and mart for the carriers of the tea grown on the hills to the north of it. From our camp beyond the village, I went up next day to the highest point of the Loi-hang range above it to the north. This proved to be another volcanic cone, but not so well marked as Loi-ûn, before described. Here the people pretend to account for the remains of the crater by a legend about a celestial peacock that, they say, nested here and deposited a golden egg. The range takes its name from this legend. The usual smoke mist prevented much useful work; but the course of the Myit-ngè river from the north was distinctly seen. Here this river runs in a very deep, rocky channel under the southern slopes of the Loi-lung, cutting through some of the lower spurs of these hills. High up the Loi-lung are seen the plantations of the Palaungs of Taungbain, where a tea is grown which is famous even in far Yunan and thither carried on mule-back by the wandering Panthay traders. These Panthays, Mussalman Chinese, are met with all over the Shan States, through which they wander by various routes into Upper and Lower Burma, bringing down hats, walnuts, dried fruits, a little silk, and other petty merchandise, and taking up clothes, salt, tea, and miscellaneous articles, including probably a good deal of ammunition. Their transport consists entirely of pack mules loaded with trestle saddles, cunningly contrived, so that the saddle and load are lifted off together at any halting place, and can be replaced in a moment. One mule is generally led, the rest follow, often muzzled to prevent them being tempted to stop to graze. The leading mule is frequently gaily caparisoned with bits of mirrors, plumes, &c. The men carry weapons for defence, but I believe they are not often molested. Their big, black dogs, somewhat like the Bhutia dogs, with cropped ears and tails, serve to guard the camp at night and do it well.

Mansam. Height about 2,160 feet.
Max. temp. 81° } March 18th.
Min. „ 58° }

I found the column at Panglôn in Taungbain territory. Here we were visited by the son of the Taungbain ruler, a very unsophisticated person, but apparently well-meaning. All these Palaungs are very dirty and uncouth: they are good agriculturists, and only ask to be let alone to till their fields and tend their cattle, like the ancient race of men, but unfortunately for them, some of their neighbours have not the same ideas. Nevertheless the Palaung carries a full stomach ofttimes when the Shan, his neighbour, is tightening his belt over an empty one. I made another fruitless ascent from here to another peak of the Loi-hang range. I managed to complete the sketching of a good deal of the Myit-ngè valley, however. On the 22nd March we marched round the southern end of the Loi-hang range, and struck the Myit-ngè river some distance above the Motè ferry, where we crossed, the men, guns and baggage on rafts and in dug-outs, the beasts swimming or crossing by the ford lower down. Motè is a small village, important only from its position as an octroi post of the Thibaw Tsawbwas. From Motè we marched to Thibaw, outside of which we were met by the Tsawbwa and personally conducted by him in a kind of triumphal walk round his capital, after which we were allowed to choose our camping-ground. This was fixed upon in the dry rice-fields to the north of the place. During our stay here I was vainly engaged in trying to connect Major Hobday's points with my work; but, as the atmosphere continued of the consistency of a London fog in November, this proved impossible. However, I connected the traverse and plane-table work all right. As the country from Thibaw to Mandalay has already been described by Major Hobday, I need say no more about it. We reached Mandalay on the 9th of April, with considerably less shoe-leather than we started with.

Panglon. Height about 2,340 ft.
Av. max. temp. 84° } March.
„ min. „ 61° }

Thibaw. Height about 1,200 feet.
Av. max. temp. 95° } March.
„ min. „ 61° }

Politically, I believe, the expedition was a great success; we were received everywhere in the most friendly manner, and peace blossomed in our footprints amongst the bones and ashes of inter-tribal war.

Geographically, 4,500 square miles of country were more or less completely mapped.

Trigonometrically, a rough triangulation was carried on (and has been worked up) to the great peak of the Loi-lin range.

Scientifically, up to Monè a Forest Officer, who accompanied the column so far, recorded, doubtless, much useful information as to the trees and flora of the southern States; but I regret to say, with the exception of the Medical Officer, who made a collection of the insects of the country, no one was in a position to use eyes, hammer, or gun usefully in the cause of science. Strange ducks and teal were certainly shot; but they went into the pot.

Big game, I can say from experience of other jungles, is scarce; but it is there. *Serow* and barking deer were found, the latter plentifully everywhere; tracks of *sámbhar* were fairly frequent, and signs of bison or wild cattle, of rhinoceros, tiger, leopard and bear were seen. Small game was abundant, including hare, jungle-fowl (red), the painted and black partridge, common and wood quail, peafowl, duck, teal and widgeon of all kinds, and a few woodcock (mostly found in Kyithi-bansam and Legya). Snipe were very scarce even in good ground.

We saw no mines of any kind worked except in the one instance mentioned of iron near Maing-ngè. Surface coal, as aforesaid, was seen in the Tein valley.

I have already acknowledged the services rendered us by the Intelligence Officer,

Lieutenant Stanton, R.A. I must also record my gratitude for the ready help and kindness of the Officer Commanding the Column, Colonel Swettenham, 27th Punjab Infantry, and of the officers under him, and of the Superintendent, Mr. Hildebrand, C.S.I., and lastly, but more especially of the Assistant Commissioner, Mr. J. G. Scott, to whom I am in great part indebted for the correct writing of local names and entirely for the record of temperatures.

Assam and Upper Burma Frontier.

Extract from the Narrative Report of Mr. M. J. Ogle, *Surveyor, 2nd grade, on the Survey operations with the* Hukong Valley Expedition.

On the 24th November 1887 the Government of India having provisionally sanctioned an expedition for the purpose of exploring routes into the Hukong Valley from Assam, I received instructions to make the preliminary arrangements.

I accordingly sent for a Khasi sirdar with the view of obtaining 30 Khasi coolies for the survey transport, and he promised to do what he could to assist me. Subsequently he was told to procure as many men as possible, owing to Mr. Needham having asked me to procure men for him.

By the 15th December he had collected 55 Khasi coolies and 3 sirdars, and he told me that it would take some time to obtain more, so being unwilling to detain the expedition, I determined to leave Shillong without further delay. This I did on the 17th with a party consisting of 1 writer, 1 compounder, 11 *khalássis*, 55 Khasi coolies and 3 sirdars.

On the 20th we arrived at Gauhati and left that place by despatch boat on the 22nd, reaching Dibrugarh on the 26th, where I met Captain Michell of the Quartermaster General's Department, and later on Mr. Needham, who had come in from Sadiya to take command of the expedition. The entire party arrived at Margherita on the evening of the 3rd January 1888.

It had first been arranged by Mr. Needham that the expedition should proceed from Margherita by what is called the Naga Hills route to Sombia Nong's village, the nearest village in the Hukong Valley, and thence, if well received, pass through the valley to Mainkhwom. But Captain Michell, who was sent up in the interest of the military authorities, persuaded Mr. Needham to abandon the Naga Hills route in favour of the one by the Nongyong Lake, and the latter route was eventually decided on. Stores had been pushed on to a village called Yogli, on the Naga Hills route, two marches from Margherita.

On the 4th January the party, consisting of Mr. Needham, the Political Officer in Command, Captain Michell, Assistant Quartermaster-General, Captain Molesworth, with 48 Frontier Police, myself, and about 100 Khasi and Goorkha coolies, besides *khalássis*, servants, &c., left Margherita. The route up to the 8th January followed the bed of the Buri Dihing, over a very difficult track, and on the 9th Mr. Needham proceeded to N'Dong on the Noa Dihing for the purpose of pushing on supplies.

On the 10th we left the Buri Dihing and proceeded along a very fair jungle path to the village of Namphai. On the 11th I started off to N'Dong, about 8 miles distant, with three elephants and all my Khasi coolies, to help Mr. Needham in forwarding on the supplies which had been collected there, and I returned the same day to Namphai. On the 12th I marched to near Ningrang, where Captains Michell and Molesworth had preceded me, and we were here joined by Mr. Needham on the 13th. On the following day Captain Michell left us for the onward move.

I shall proceed now to report each day's proceedings in diary form.

January 15th.—After a false start, I at last struck the path, and followed the one taken by Captain Michell, carrying a route survey. March 6½ miles.

16th.—Captain Michell, who was travelling with elephants, had a hard time of it, as he was obliged to cut his way and make foothold for his elephants. I therefore caught him up on this day. He was encamped just below the crest of the Patkoi. March 7 miles.

17th.—I started for the Patkoi ridge, leaving my camp standing, and commenced clearing a point to the east of where the path lay, and another close to the path in the west. The latter was bare to the south, but it looked over country that had already been surveyed, so all I could do was to take rays to points beyond. I was clearing the second hill for the purpose of looking up the valley of the Loglai, but it necessitated very heavy cutting, and not much was done.

18th.—Captain Michell proceeded on his journey. I was unable to go out, being down with fever, but my coolies went up and continued clearing the hill to the east. It rained heavily during the day and came down harder towards evening.

19th.—I was again unable to go up the hill owing to fever.

20th.—Mr. Needham and I marched over the crest of the Patkoi. Before leaving the ridge I again set up my plane table and theodolite and fixed the height of the pass by taking vertical angles to three trigonometrical stations, and found the height to be 4,147 feet above sea-level and not 4,655, as shewn in the published sheets of 1876-77 and 1884-85. The height at foot of Patkoi on the Nonki is 1,063 by aneroid; thus the ascent to the pass is 3,084 feet. I also continued the route survey. After leaving the Patkoi we descended an easy spur till we struck the Nongyong river, 2,796 feet above sea-level, and began to ascend the Digung hill, and camped about a quarter of a mile up it. March 8 miles.

21st.—We crossed under the Digung hill at an elevation of about 3,500 feet and began to descend into the Digung stream. Thence our path lay along the bed of that stream and occasionally through jungle along its banks till we reached the Loglai and set up camp a little below the junction of the Digung with it. Elevation 1,212 feet, and length of march 7 miles.

22nd.—We crossed the Loglai some 100 yards lower down, and after ascending and winding round spurs descended till the Loglai was again struck. Here we had to get to the other side over rather a bad crossing. Thence the path led up the Katsu stream over large boulders for some 2 miles, and then turning off from it began to ascend a hill, the highest point which we attained being about 2,500 feet above sea-level. We then descended about 900 feet and pitched camp in the bed of the Namlip. March 10 miles.

23rd.—There was rain last night. Mr. Needham and I continued our march down the Namlip. The first portion of the route for about a mile lay over large boulders, thence for 4½ miles either along the bed of the river or through flat belts of forest to cut off long bends, and then struck the Yungshung, following which some little distance we camped in its bed. March 9 miles. There was rain during the night.

24th.—We struck camp and proceeded up the bed of the Yungshung for 3 miles, and eventually got on to a ridge which is known by the name of Numyung or Nengru, about 2,600 feet. From thence we descended to the village of Numyung by an exceedingly slippery and steep path and pitched camp there. March 9 miles. Elevation 959 feet.

The path we struck after leaving the Yungshung is not the regular one used by the Singphos and Nagas in getting to the village of Numyung or over into Hukong, but is a short cut into that village and is allowed to run to jungle in order to prevent runaway slaves from readily finding it, so we had considerable difficulty in getting along, as the guide kept repeatedly losing his way and a lot of jungle-cutting had to be done.

Just before arriving at Numyung the messengers, whom Mr. Needham sent into Hukong last month with letters to three of the Singpho chiefs, advising them of our intention of visiting their country, had caught us up. The replies sent by them were not entirely satisfactory, yet there was no prohibition implied to our entering the valley.

25th.—There was rain off and on during the night. I went back to the Nengru ridge to clear a point for survey purposes, and after some difficulty, owing to the flatness of the range, succeeded in finding a suitable spot.

26th.—I went up to Nengru ridge again. The point was cleared sufficiently by 3 P.M., and I sketched in all that could be seen from it. I had carried a route survey up to Numyung village from the pass over the Patkoi, and on setting up my plane table in the Nengru ridge, and having plotted the route on the board, I found the difference between the plane table fixing and that obtained by the route survey to be only half a mile.

27th, 28th, 29th.—These were very wet miserable days. While Mr. Needham was waiting at Numyung for the provisions to come in from Yogli, I was anxious to proceed in advance along the road which went over the Khathung range to the village of Dapha Nong (a Singpho chief in the Hukong valley), to clear a point on it. This range was distant two days' march from camp. If the expedition through want of supplies could not have followed, I should have had ample time to reach the range, clear a point on it, sketch all that could be seen and return to Numyung before the party left that place; but the constant rain rendered a move impossible, and I was consequently obliged to remain in inactivity.

30th.—About 5 P.M., some 70 Nagas, chiefly women, children of both sexes, and old men came in bringing with them about 14 maunds of rice and nothing else. A Khasi, who had been sent in advance to arrange for its transport here, returned and said that nothing more was coming. So here was the first indication of a break-up of the expedition. The Political Officer then decided upon going westwards into the Naga hills, by which route we would be advancing towards our supplies, and probably be enabled to explore some portion of the road through the Naga hills.

31st.—Forty more Nagas came in to-day, bringing more rice and a little *dal*, but our plans for the new route could not be changed, both on account of the want of porters and of the insufficiency of supplies.

1st February.—We left Numyung, reached a point on the Numyung river seven miles from our last camp, where we halted for the night. Owing to my having suffered from fever during the past two nights I was too weak to carry on a route survey, so I was obliged to leave this work to Captain Michell's soldier-surveyors.

2nd.—Went up the Numyung some two miles and crossed it three times, after which we left it altogether and ascended a low hill about 200 feet above the river and descended into the Siri stream. We kept along the bed of this stream, and through a flat bit of country for some four miles, and then began a gradual ascent till we reached an elevation of about 3,000 feet and then dipped down into the Dilli stream, which we crossed at about 2,750 feet above sea-level. We then continued to ascend gradually till we arrived at a small Naga village. Thence the path led us up a steep ascent for a short distance, winding round several spurs, till a large Moshang Naga village was reached, where we pitched camp. March 30 miles. Height about 3,900 feet above sea.

3rd.—Mr. Needham decided upon halting here to enable me to go up to a hill called Ran, 2,700 feet above the village, to clear it. I accordingly left with 80 Khasi and Goor-

kha coolies, but on arrival at the summit I was very much disappointed to find that it was a great, broad-topped hill, densely covered with forest trees of enormous girth. Fortunately round two sides of the hill it was rocky and precipitous, so much clearing was not required there. I, therefore, set most of the axes to work on the other two sides.

A Naga accompanied as guide to Ran. He took with him a fresh-laid egg. When we arrived on the ridge and just below the peak he cut a bamboo, and, having split it at one end, fixed the egg into it and drove the other end into the ground, leaving it standing upright. This is one of their customs of propitiating the sprites who are supposed to reside on all high hills. The Nagas declare that the sides of this hill ignite spontaneously in the hot weather.

4th.—The hill had not been cleared enough yesterday, so I again sent up the coolies this morning and followed later on, setting up my plane table on the way in the clearings. It was not till late that the hill was sufficiently cleared, and I had to dodge about it to get a view of the country at all points of the compass, and by 4-30 P.M. I had finished, but not a bit too soon, as the surrounding ranges became totally obscured with clouds.

5th.—We halted on account of heavy rain.

6th.—There was heavy rain last night. No provisions coming in, we marched to Phung, 5½ miles distant. This village is situated on a flat-topped ridge, height 4,043 feet above sea, and containing some 15 tumble-down-looking houses. It is on the high way to Ledu and Margherita, and the Nagas, who are constantly backwards and forwards, collecting rubber, halt there for liquor and food.

7th.—To-day I was engaged in inking up my plane table, and in the afternoon started round about the village plane tabling. In the evening some Nagas came in with supplies from Yogli. On my representing to Mr. Needham the great advantage that would be derived by my going to the village of Modai, two days' march from here, even though the whole party could not follow, he consented to my doing so.

8th.—I left this morning with an escort of 20 men of the Frontier Police and 2 Havildars with my own establishment of *khalássis* and coolies and surveyed *en route* to Morang, the first day's march out, and distant 9 miles. This is a fine large village containing about 70 houses and is situated at an elevation of about 4,200 feet. The people were friendly and brought me a goat, which I purchased for the men.

9th.—I marched to Modai, plane tabling *en route*. Immediately on leaving the village, the path led some 2,500 feet down a very steep spur to the Namphuk river, and continued along the bed of it for 3 miles; thence a steady ascent of 3 miles more up another spur brought us to the village of Modai, which contains about 75 houses. About a mile below the village we came upon some fields in which there were a few men and several women working. Two of the former had flint-lock muskets, and all of them on seeing us suddenly emerge from the forest, appeared frightened and were making off. They were soon reassured, however, and on our arrival at the village the people turned out and helped us to clear a spot for the camp. March 9 miles. Height 4,456 feet.

10th.—It rained last night and continued cloudy and foggy all day, with rain off and on. The day was spent in bargaining with Nagas for goats, fowls, rice, &c. Rice I was particularly anxious to get, as if I could have procured even a couple of maunds from each village we passed through, our chance of getting into the Hukong valley would have been almost assured, but alas! I was only able to get 32 seers out of them after much trouble. The Nagas will do a great deal for opium, but I could not get them to part with their rice, though I offered to pay well for it and to throw in a liberal quantity of opium besides.

11th.—In the early morning just the top of the Patkoi and high ranges were visible, all being covered with a good deal of snow, but everything else was hidden in fog. In the afternoon, I went to a point beyond the village, and the fogs and clouds having fortunately cleared off, I succeeded in obtaining the survey I wanted.

12th.—Marched back to Morang, where I found Mr. Needham and Captain Michell had arrived and were just pitching camp.

13th.—The march to-day, though only 6 miles, was trying. The path led to the Dilli, a descent of 2,500 feet, in about 2½ miles, the point where we struck the river being 1,700 feet above sea-level. The ascent to Shánggé, about 3½ miles, was equally steep, the rise being about 3,500 feet in that distance. Shánggé contains about 60 houses; there were few men in the village, most of them being out rubber-cutting, but those who were there appeared friendly. As elsewhere, we could get no rice out of them. Height of village 5,174 feet above sea-level.

14th.—Heavy rain fell nearly all last night. The morning, however, turned out fine, and we marched. The path for the first two miles led up the back of a spur thrown out from the MuBum range at an easy gradient, after which it wound about a number of cross spurs until it reached the pass 7,124 feet above the sea, or 1,950 feet above the village, and distant 6 miles. Here were the usual gift offerings to the hill sprite who resides there, namely, eggs inserted into the end of bamboos which are driven into the ground. I started on the march with a fever and ague on me, but shook it off by the time I reached the pass, and from there commenced a route survey. We pitched camp on a bit of fairly level ground on the Khalung stream, some two miles below the MuBum range. Length of march 8 miles and about 1,950 feet below top of pass.

15th.—The Khalung stream takes its rise from the MuBum peak, 8,230 feet above sea-level. We crossed this stream and reached a small hamlet of two houses, an offshoot

of the village of Shánggé, on the north side of the Mu Bum. About 200 feet above it was an open spot, on which I set up my plane table. I spent about an hour there sketching in the lower features, the hill tops being enveloped in clouds, and then proceeded to join the party which had gone on, continuing my route survey. The path descended about 900 feet steeply into the Waga stream, and after a short ascent I found the camp only 5 miles from our last halting place.

16th.—I started ahead with Mr. Needham, route surveying and sketching, and marched to the village of Hashan, which has about 10 houses in it. Distance 6 miles. Height about 2,400 feet.

17th.—Mr. Needham, Captain Michell and I with a small escort and 50 coolies left Hashan for Khulluk, distant about 5 miles to the east. It is situated on a tolerably flat spur at an elevation of about 4,000 feet, and contains some 22 houses.

18th.—Mr. Needham and I started with a small escort and some coolies to the village of Lungshai, distant about 7 miles to the south, and came to a spot overlooking the village. A good view could be obtained from this point all round, but, as usual, the weather was unpropitious and the tops of the higher ranges were covered with clouds. However, by patient waiting a good amount of work was done.

From this point we could see a high range of hills, distant, I should imagine, some 50 or 60 miles to the west, trending in a south-westerly direction; and about 30 miles from us, in the same direction, were low and intricate hills, which appeared to die away to the south into the Hukong plain.

19th, 20th, 21st.—We turned our backs towards the Hukong valley on the 19th, to my great regret. We had rice to last us to the morning of the 23rd, and it would have been most profitable for survey purposes had we visited Lungwak, a bare rocky peak situated on the last marked range overlooking the Hukong valley. A day spent on the ridge there would have obtained for us a fair geographical knowledge of a couple of hundred square miles of country and a rough idea of a good deal more country. We retraced our steps to Phung by the same route as we had come, and the clouds having lifted, an extended view of the country was obtained. I set up my plane table whenever I had an opportunity, and verified my route positions by interpolations, and sketched in whatever was faulty and unfinished.

22nd.—We marched from Morang and passed through the village of Phung, descending into the Namphuk, about 1,400 feet below the village, and camped a little above the river-bed. March 10 miles.

23rd.—We marched across the Patkoi. The pass is 7,192 feet above sea-level, or about 4,536 feet above the bed of the Namphuk at its crossing. This Namphuk must not be confounded with the river of the same name on the north side of the Patkoi range. The latter river, after it emerges from the hills into the plains, is called the Buri Dihing. From the crest of the Patkoi, the descent to the Namchik is a long but comparatively easy one, though in two or three places it is very steep and winds considerably. The distance to the Namchik is about 6½ miles and is 4,597 feet below the pass, or 2,595 feet above sea-level. Length of march 12 miles.

24th and 25th.—We marched about 11 miles and camped 1½ miles below the village of Yogli.

We had now been marching continuously for 13 days, so on the 25th we determined to make a halt, a luxury which all appreciated, and I employed my time during the day in inking up my survey.

26th.—We went through Yogli, crossed the Tirap river, and encamped below the village of Lungshang, 6 miles from our last halting place.

27th.—Proceeded through Lungshang down into the Tikeng stream, then ascended to the village of M'bang (not shown in Captain Samuell's map), and went on and camped in the bed of the Namdeng. March 10 miles over easy ground.

28th.—Marched into Margherita, 8 miles, and halted there on the 29th.

The party arrived at Dibrugarh on the 4th March and embarked for Gauhati and Calcutta on the 6th.

Description of country surveyed.

The country that came under survey lies approximately between latitude 26° 30′, 27° 15′ and longitude 95° 30′, 96° 30′. There are two high ranges in this tract. One, the well-known Patkoi, to the north, running north-east and south-west, having peaks on it which vary in height from 4,150 feet to 7,200 above sea-level. The other, which is known as the Mu Bum range, runs almost parallel with the Patkoi and to the south of it, is not of nearly such great length as the Dilli cuts through it at its south-west extremity and the Turong river at its north-east. This range has peaks rising from 4,500 feet to nearly 8,300 feet above sea-level. Both these ranges are densely wooded and throw out long spurs, upon which at an average altitude of 4,000 feet are situated numerous Naga villages, some of them rather large, having as many as 110 houses. Moshang is the last of the Naga villages to the east, and the country thence eastwards is totally deserted over a very large area, with the exception of a few Singpho hamlets on the Numyung and Turong rivers. To the south of the Mu Bum is another prominent range, which is the last marked one and overlooks the Hukong plain. It is rugged and rocky, the peaks being pointed and precipitous. A few small Naga villages occur between these two ranges, Khulluk being the last one to the east.

Route to Numyung described in detail.

From Ningrang, or from the deserted village of Namphuk to the foot of the Patkoi, at a point on the Nonki stream, is not more than 12 miles, and its elevation is 1,063 feet above sea-level. The path, on leaving the Namphuk river, goes up the bed of a very small stream over a gentle slope, then crosses a watershed and down the bed of another small stream, when it strikes the Namphuk again. The track crosses and recrosses the river several times, and then leaves it and goes up the Nambong and Nonki streams. A bridle path could very easily be made without the necessity of wading backwards and forwards through the river by keeping along its left bank. The real ascent to the Patkoi is commenced after the Nonki stream is left at 1½ miles from the top; the ascent in that distance being 3,084 feet. The first ascent after leaving the stream is rather stiff for a quarter of a mile, being about 900 feet, and the last portion for about the same distance from the top of the pass is also steep, the ascent being about 1,200 feet. This leaves a tolerably easy ascent of about 1,000 feet in the intervening mile. But by winding round the base of the spur I have no doubt an easy gradient for pack animals could be found, and by striking the crest of the Patkoi about half a mile to the west of the point over which the present path lies, a lower dip in the range would be met.

The descent from the pass to the Nongyong stream over a direct distance of 3½ miles is only 1,350 feet. From here the path ascends the Digung hill, and in a distance of 1½ miles rises 700 feet: there is then a long descent of about 2,300 feet in 3½ miles to the Digung river, and between this point and the Loglai, which is met about 1½ miles further on, the path goes along a flat bit of ground nearly the whole way. The Loglai is crossed a little below this, but the reason for this is, I fancy, to get to the Singpho villages on the Turong. An old path exists on the right bank of the Loglai, and this might be utilised more profitably than the present ones, as it would avoid bridging the river. The path emerges on the Loglai, at its junction with the Katsu stream. The elevation here is about 1,230 feet above sea-level; thence, up to the crest of the hill in a distance of nearly 2 miles, the ascent is about 1,270 feet. There is a very steep descent into the Namlip of about 900 feet in half a mile, and this part of the road could not be utilised, but would, I imagine, have to wind round under the ridge to the west and made to strike the Namlip some 3 or 4 miles lower down than where we camped on the 22nd January. Thence the path after going down the Namlip and up the Yungshung might turn off to the east from the spot where we were camped on the 23rd January until it meets the Nengru ridge and descends into the Numyung. About 2 miles below the great bend, the river takes to the south after leaving the village of that name. Thence the path would cross the river and join the one which comes from Numyung village. This path keeps along the right bank of the Numyung and crosses the Dibu, Takhan, and Kathang streams, the height at the last-named stream being approximately 800 feet above sea-level. From this point it begins to ascend the Kathang range and crosses it at about 4,000 feet approximately, that is a rise of 3,200 feet in 6 miles in a direct line. The total distance from Namphuk deserted village to the village of Numyung is 59 miles, and to the Kathang pass by the route described after leaving our camp on the Yungshung about 70 miles.

The distance from Margherita to Khulluk, the furthest point we reached on the Naga hills route to Hukong, is 88 miles.

By the Nongyong lake route, at Numyung we were ten marches from Mainkhwom and eight from Dapha Nong's village. By the Naga hills route, at Khulluk, we were seven marches from Mainkhwom and two from Sombia Nong's village, having got nearer to Mainkhwom by the latter route.

The Loglai, next to the Turong, is the largest river in the country which came under survey. The Dilli is the next, then the Numyung, and lastly the Taga. The positions of 33 villages which were quite unknown before have been fixed and 1,500 square miles of country have been surveyed, about 1,400 of which is entirely new, and this result was achieved in spite of the bad weather we had from the very day we reached the Patkoi till we began the return march to Margherita.

The topography was extended south of the Patkoi in continuation of the survey which had been done in 1873-74, and this new work was also linked on to what was accomplished by Colonel Woodthorpe in 1884-85 to the east.

Triangulation could not be attempted, as it would have necessitated visiting the old stations of Maium and Nunnun, and this with the time at our disposal was not possible.

The Nagas to the south of the Patkoi, called Rangpangs, are human sacrificers. The victims are sometimes those taken in battle, but are oftener slaves who have been purchased. The manner of sacrificing is thus performed. The unfortunate being, who may be of either sex, or even a child, provided it has cut its teeth, having been tied hands and feet, is made to stand in the front verandah of the sacrificer's hut, when his hair having been seized and the head pulled forward and bent downward, a man, hitherto unseen, steps out and severs it from the body with a stroke of his Singpho knife. The chest is then cut open by the relations of the sacrificer and a search made for the heart, and the one who first gets hold of it is looked upon as a very lucky person. The fingers and toes are then cut off and stuck into pointed bamboos close to the sacrificer's hut, where they remain until they rot away, and the body is taken up to a high hill to propitiate the sprite who is believed to reside there. The flesh is taken off the head and is likewise buried close to the sacrificer's hut, and the skull divided among the relations who have subscribed to purchase the slave. For the account of this custom I am indebted to Mr. Needham.

I have every reason to be thankful to Mr. Needham for the assistance he readily and willingly gave me whenever I asked for it; but for this I could not have succeeded as well as I did.

TRANS-HIMALAYAN EXPLORATIONS.

Notes by COLONEL H. C. B. TANNER, *on Reconnaissances and Explorations in Nepal, Sikkim, Bhutan and Assam.*

Snow peak triangulation and sketching of Independent Himalayan Tracts.—The reconnaissance of the Nepal Himalaya was continued by Sub-Surveyors Rinzin Nimgya and Ram Saran, from tower stations of the Great Trigonometrical Survey on the N. E, Longitudinal Series. Observations were taken from thirteen tower and two auxiliary stations, from which a great deal of rough topography was obtained by Rinzin in the drainage areas of the Káli, Karnáli, Sarju and Rápti rivers. This reconnaissance and triangulation covers an area of 25,975 square miles of country. We now have a reconnaissance of this class for the whole of Nepal, excepting a gap of some ten miles to the west of the Gandak river. Along the eastern boundary of Kumaun a strip of topography based on a trigonometrical survey of the more prominent peaks was executed by Rinzin and myself three years back and the survey of the past season by Rinzin tends to strengthen that work. To the east of the Gandak river, and stretching up to Sikkim the reconnaissance was carried out by Mr. Barckley and myself, while the survey of the Nepal boundary was in progress, and along the western boundary of Sikkim the work was done by Mr. Robert and myself during the prosecution of the Darjeeling survey.

Our present knowledge of Nepal Geography.—Besides the reconnaissance surveys obtained from distant sketching based on trigonometrically fixed points alluded to above, the only other information we possess of Nepal, except a survey of the Khatmandu valley by Major Wilson and Captain Barrow, is derived from the route surveys of the native explorers who, from time to time, have traversed the country. Some of these surveys are of excellent quality, some are indifferent, and some that have been done are so inaccurate that they are of little or no practical use. Wide gaps occur between the routes followed, and though at present no explorations are being carried out in Nepal, there is every hope that the work may soon be resumed. Distant sketching based on trigonometrically fixed peaks affords a fairly good basis whereon to adjust the traverses and topography of the explorers, but it is very difficult work, and can only be prosecuted during the very few days in each year when haze is absent from the atmosphere and when clouds do not envelope the hill ranges. With the exception of a blank of some ten miles wide which occurs on the west of the Gandak river in Central Nepal, the whole country has been sketched in some form or other from the towers and other stations of the Great Trigonometrical Survey in the plains and from the hill stations of Kumaun in the west and Sikkim in the east, but such work, being the results, in some cases, of sketching done from points a hundred miles distant, is necessarily vague and incomplete and at the most only secures the tops of the more conspicuous ranges. It may also be said that this class of work can never be of a final nature, and after once going along the plains skirting the five hundred miles of the Nepal hills, it stands to reason that even the most skilled observers, who have special aptitude for the work, must have sketched large tracts very imperfectly. This is more specially the case with the attempted distant sketching of one of the most important tracts from a military point of view encountered by my party, namely the hilly region between Khatmandu and the plains of India. Several routes which cross these hills have been reported on by the officers of the Intelligence Branch of the Quartermaster-General's Department, the descriptive information of which is all that could be desired; but the maps accompanying are fragmentary and not continuous, and as they have not been corrected by observations with any trigonometrically fixed points, they cannot be embodied on my sketch map with any hope of accuracy. The survey of the valley of Khatmandu by Major Wilson and Captain Barrow is a superior piece of work, and it has been fairly well fixed in position, by the first-named of these officers, by observations to well-determined snow speaks. Had similar observations been taken to snow peaks from the various high places on the routes between the British boundary and Khatmandu, the sketch maps by the officers of the Quartermaster-General's Department might have been accurately incorporated with my geographical maps. The Nepal ranges neighbouring the Chiriaghat pass and the gorge of the Bágmati river offer few salient points which can be fixed by a trigonometrical survey, but as these hills have been confronting our surveyors working in the plains of Bengal for a generation, it seems surprising that up to this date we should still be in a state of almost complete ignorance regarding them. The meagre topography secured requires to be strengthened by further observations from the trigonometrical stations on the Sumesar hills and from stations in the plains near Bikna Thori and the neighbourhood.

The chief difficulties attending the distant sketching and trigonometrical survey of independent Himalayan topography are due to the hazy and cloudy state of the atmosphere, and on this account it is not unlikely that many high peaks in the higher Himalayas have escaped us. Haze nearly always envelopes the central band of mountains running right through Nepal, situated about midway between the exterior hills and the more distant snows, and here we have not been able to do much either in the way of topography or of trigonometrical operations, and up to date have only secured a small number of the more salient features. The higher snows are seldom visible after 8 or 9 A.M., and then

only during a limited number of days in the year. During the operations of the Great Trigonometrical Survey, more than thirty years ago, very few great peaks escaped the observers from the tower stations in the plains, and it is the more conspicuous points in the central and outer bands of mountains that have chiefly engaged our attention.

Reduction of observations.—With regard to the reduction of the observations to points on the Nepal Himalayas, the angles have been abstracted and charts made from rays drawn with long-armed station pointers, and in this state it is proposed to hand over the work to the Dehra Office for completion. The examination of the abstracts of horizontal angles shews that many of them are of fair accuracy, but there is a great want of verticals, and as a rule these latter are of bad quality. During the past season one of the observers broke the spider lines of his telescope and was only able to replace them in the field with hairs far too coarse to admit of accurate work.

Bhutan and Assam.—The distant sketching of Bhutan topography is confined to that done by Mr. Robert from trigonometrical stations on the eastern boundary of independent Sikkim. No work of this kind has ever been done from the tower stations in the plains adjoining Bhutan. The trigonometrical charts of the Assam Longitudinal Series shew that some mountain points have been fixed from the stations of the series, but the discrepant values of some of the heights shew that the observer has occasionally mistaken one peak for another. In Eastern Assam, Colonel Woodthorpe and Lieutenant Harman executed a trigonometrical survey of peaks around the gorge whence the Sangpo and Dibong rivers issue from the Himalayas, but the work is by no means complete. The further prosecution of this survey is a desideratum, for by continuing it, it is likely that the vexed questions relating to the lower course of the Sangpo may be set at rest. The publication in last year's report of my map of the course of the lower Sangpo, derived from an amalgamation of the information given by K. P. with that of Captain Harman's unpublished plane table sketches, has called forth a paper from General Walker, printed in the proceedings of the Royal Geographical Society for September 1888, who draws conclusions regarding the hydrography of south-eastern Tibet at variance with my views. General Walker in map No. 4 accompanying the paper turns the waters of the Nagong Chhu into the Dibong river instead of allowing them to flow as maintained by K. P. into the Sangpo at Miri Padam. Now whatever difficulties there may be in allowing such a small drainage area to the Dibong—and I confess that with a discharge of 27,202 cubic feet per second the area as represented on my map (No 1 of the pamphlet) seems altogether inadequate—yet in disposing of the waters of the Nagong river, as he has done, General Walker ignores one or two very important items of evidence in favour of the Nagong Chhu as being the stream which enters the Sangpo at Miri Padam, and I here state them :—

(1) The Nagong Chhu is called indifferently Zyul Chhu or Yang Song Chhu by K. P., the only explorer who has seen it at its junction with the Sangpo at Miri Padam. K. P. distinctly informed me that the river drained Zyul Ted, or the country called Upper Zyul, and if any dependence can be placed on this witness, it is clear that the Nagong cannot discharge itself into the Dibong.

(2) Captain Harman sketched the range through which General Walker conducts the Nagong into the Dibong, and his plane-table sketch, though incomplete and still in pencil, appears to me to shew the range as continuous and without a break where General Walker shews the exit of the river through it. It is next to impossible that Captain Harman, with the range confronting him at a moderately short distance, could have failed to notice the gorge of the Dibong, should it exist anywhere in the locality where General Walker places it, when, at the time of survey, Captain Harman must have been much exercised in his mind as to the disposal of the great body of water of the Dibong, the discharge of which he had just previously or shortly after measured. It is true that on the map shewing Captain Harman's river discharges the area assigned to the Dibong is very small, and that we must therefore account for the great volume of water that comes down it into Assam in a more rational manner than has been done on the map of the lower Sangpo by myself, and it is therefore proposed to carry out further operations next season, so that, if possible, the conflicting theories of geographers with respect to the course of the great streams which enter Eastern Assam may be solved. In carrying out this work, the difficulties encountered years ago by Harman must be again faced, and the observers must be prepared to accept a minimum of result after undergoing a maximum of discomfort together with some little danger. Harman's narratives paint in the most vivid colours the continuous state of cloud and rain, and the annoyance he had to endure from myriads of leeches and ticks and other pests.

Sikkim.—The map of Independent Sikkim is almost entirely due to Mr. Robert, who was employed on this very arduous survey for three seasons. The area secured in the time, 2,700 square miles, is far beyond the capacity of any one surveyor, however enthusiastic and hardy, and it is not to be supposed that the resulting map gives anything but the outcome of a hasty reconnaissance. To the west of the great Kanchinjanga group of snow peaks, Rinzin's reconnaissance of the north-eastern corner of Nepal and the barren tract round Khámba Jong in Tibet forms a continuation of Mr Robert's work, but this last has not yet been fair drawn and is therefore unpublished. When Rinzin carried out this extremely difficult survey, he was but imperfectly acquainted with topographical operations, and his map is more or less imperfect ; it still, however, supplies a good deal of information which at some future time may possibly come in useful.

DRAWING OFFICE, CALCUTTA.

SECTION I.—GEOGRAPHICAL DRAWING AND COMPILATION.

Statement showing the work performed during the year 1887-88.

TITLE.	Number of Sheets.	Scale.	REMARKS.
Atlas of India.		In. M.	
Sheets Nos. 11 S. E., 14 S. W., 14 N. E., 21 S. E., 21 S. W., 21 N. W., 22 N. W., 24 N. E., 36 S. W., 37 N. W., 37 S. W., 90 S. E., 91 N. E., 91 S. E., 91 N. W., 91 S. W. . .	16	1 = 4	Additions to outline and names for engraving.
Do. Nos. 14 S. E., 15 N. W., 22 N. E., 49 S. W., 50 S. E., 60 N. E., 125 S. E. . .	7	1 = 4	Hills brush-shaded for engraving.
Do. Nos. 30, 31, 47, 48, full plates.	4	1 = 4	Additions to railways, canals and changes in boundaries.
General Maps.			
India. Engraved . . .	6	1 = 32	Additions to date.
Do. do.	1	1 =256	New edition. In progress.
Do. Lithographed . .	6	1 = 32	New edition, being completed for lithography from the copper-plates.
Do. Skeleton . . .	4	1 = 64	Showing only district boundaries; corrected to date.
Do. do.	4	1 = 48	Prepared and published in outline, showing the divisions of India with their districts, principal towns, places of note and railways open, in progress and proposed. Prepared for Secretary of State for India.
Do. do.	2	1 = 64	
Burma and adjacent countries .	4	1 = 32	Being compiled and drawn on 24-mile scale for reduction. All four sheets in hand; outlining well advanced.
Afghanistan	4	1 = 24	Compilation of S. E. Section completed and the hill drawing of all four sections in progress.
Provincial Maps.			
Bengal	2	1 = 16	Boundaries, &c., under correction.
Assam	1	1 = 16	Roads and boundaries corrected.
Mysore State	1	1 = 16	Boundaries corrected.
Upper Burma	1	1 = 16	Fourth edition. One-fourth part of outlining completed.
Punjab and its dependencies .	4	1 = 16	Being corrected according to instructions received from civil authorities. Is being engraved.
Gujarat	1	1 = 16	Brought up to date. Is being engraved.
North-West Provinces and Oudh	2	1 = 16	About half completed.
Divisional Maps.			
Dacca	3	1 = 8	Three-fourths completed.
Patna	4	1 = 8	Boundaries, &c., corrected.
Bhagalpur	2	1 = 8	Drawing completed.
Rajshahi	4	1 = 8	Do. do.
Burdwan	2	1 = 8	Boundaries, &c., corrected and final press order given.
District Maps.			
Jhansi	2	1 = 2	Additions made owing to transfer of villages from Gwalior.
Darjeeling	1	1 = 4	Compilation completed—publication delayed for want of information regarding changes in Daling Fort.
Sarun	1	1 = 4	Roads and boundaries corrected.
Nowgong	1	1 = 4	Prepared for lithography by transfers from copper and corrected to date.
Sibsagar	1	1 = 4	
Durbhunga	1	1 = 4	
Hazaribagh	1	1 = 4	
Chanda	1	1 = 4	

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SECTION I.

Statement of work—continued.

TITLE.	Number of Sheets.	Scale. In. M.	REMARKS.
Standard Maps.			
CENTRAL INDIA AND RAJPUTANA—			
Sheets Nos. 385, 386, 387, 388, 402, 404, 405, 415, 416, 417, 418.	11	1 = 1	Outlining and hill-shading completed; final press order given.
BOMBAY—			
Sheets Nos. 37, 38, 86, 87, 88, 89, 103, 119, 215.	9	1 = 1	Completed headings, foot-notes, references, &c. final press order given.
UPPER BURMA (N.-E. TRANS-FRONTIER SERIES)—			
Sheet No. 22 . . .	1	1 = 8	Redrawn in vertical hachures; final press order given.
Sheets Nos. 15, 23 . . .	2	1 = 8	In progress. Outline almost finished.
Sheets Nos. 14 S.E., 22 S.W., 22 N.W.	3	1 = 4	Final press order given for 22 N.W.; the remainder in progress.
UPPER AND LOWER BURMA (S.-E. TRANS-FRONTIER SERIES)—			
Sheets Nos. 1 N.E., 1 S.E. .	2	1 = 4	Compiled by Colonel Woodthorpe and Major Hobday; drawn and finished in the Drawing Office, Calcutta. Final press order given.
Sheets Nos. 2 N. E., 2 S. E., 3 N. E., 4 S. W., 5 S. W., 5 N. W., 6 N. W. . .	7	1 = 4	Compiled by Major Hobday; heading, foot-notes, references, &c., finished in Drawing Office, Calcutta. Final press order given.
LOWER BURMA—			
Sheet No. 227 $\frac{N.W.}{3}$ . .	1	4 = 1	Completed heading, foot-notes, references, &c.; final press order given.
N.W. TRANS-FRONTIER SERIES—			
2 Maps	2	1 = 4	Redrawn and press order given.
2 „	2	1 = 4	Being redrawn, almost finished in outline.
3 „	3	1 = 4	Drawn and press order given.
4 „	4	1 = 4	Brought up to date.
3 „	3	1 = 2	Brought up to date and press order given.
5 „	5	1 = 2	Foot-notes and border completed and press order given.
5 „	5	2 = 1	Ditto ditto ditto.
1 „	1	1 = 16	Published in outline.
Administration Report Maps.			
Punjab Province . . .	1	1 = 32	Railways brought up to date; press order given.
„ „ . . .	1	1 = 80	Ditto ditto ditto.
North-West Provinces and Oudh	1	1 = 80	Ditto ditto ditto.
Bengal Province . . .	1	1 = 80	Ditto ditto ditto.
Assam „ . . .	1	1 = 48	Commenced, in progress.
ASSAM—			
Sibsagar, Cachar, Lakhimpur, Darrang districts . .	1 of each	1 = 8	Ditto ditto.
RAJPUTANA—			
Ajmere, Merwara districts .	1 of each	1 = 8	Ditto ditto.
COORG	1	1 = 8	Partly drawn.
N.-W. PROVINCES—			
Jhansi district . . .	1	1 = 8	Press order given.
BENGAL—			
Chittagong Division . .	1	1 = 24	Ditto ditto.

DRAWING OFFICE, CALCUTTA.

SECTION I.

Statement of work—continued.

TITLE.	Number of Sheets.	Scale.	REMARKS.
		In. M.	
Index Maps.			
India showing progress of Imperial Surveys	1	1 = 128	Corrected to 1st October 1888.
The G. T. Survey of India	1	1 = 96	Do. do.
Survey Operations in Baluchistan	1	...	Do. do.
Ditto Himalayas	1	...	Do. do.
Ditto Madras	1	...	Do. do.
Ditto Gujarat	1	...	Do. do.
Ditto Mirzapur	1	...	Do. do.
Forest Surveys, Lower Burma	1	...	Do. do.
Forest Surveys, Districts Hoshangabad and Betul	1	...	Drawn and press order given.
Forest Surveys, Bombay (North Division)	1	...	Corrected to 1st October 1888.
Geographical Surveys in Upper Burma	1	...	Do. do.
Standard Sheets, Bombay Presidency	1	...	Do. do.
Statistical Maps.			
India showing percentage of cultivated area of Indigo	2	1 = 64	Copy prepared in tints for lithography.
Do. do. Tobacco	2	1 = 64	27 copies hand-tinted.
Do. do. Cotton	2	1 = 64	125 do. do.
Do. do. Rice	2	1 = 64	31 do. do.
Do. do. Jute	2	1 = 64	16 do. do.
Triangulation Charts.			
Kubo and Chindwin Valley	1	1 = 8	Projected and drawn and final press order given.
Miscellaneous Maps.			
Country to the north, east and west of Landour	1	1 = 32	To accompany panorama of the snows from Landour. Commenced and completed.
Simla Guide map	1	6 = 1	New edition Drawing completed.
Simla and Jutogh	1	24 = 1	Inserted additions in original sheet.
Deesa cantonment and environs	6	8 = 1	Inserted border, heading, foot-notes and references; final press order given.
Jeypore State	1	1 = 8	Reduced from ½ inch maps; final press order given.
WORK DONE FOR OTHER DEPARTMENTS.			
Bengal, Trade	1	1 = 48	Illustrating rail-borne trade.
Do. Income Tax	1	1 = 80	Showing distribution according to net demand.
Do. do.	1	1 = 80	Showing proportion of persons assessed to that of population.
Do. do.	1	1 = 80	Showing incidence of taxation represented by number of persons assessed to each rupee.
Do. Sanitation	1	1 = 80	Showing mortality from cholera.
Do. do.	1	1 = 80	Showing mortality from fever.
Do. do.	1	1 = 80	Showing mortality from small-pox.
Do. Police	1	1 = 80	Showing cognizable crime.
Do. do.	1	1 = 80	Showing serious offences.
Do. do.	1	1 = 80	Showing dacoity.
Do. do.	1	1 = 80	Showing minor offences.
Do. Excise	1	1 = 80	Showing incidence of total excise revenue on population.
Do. Country Spirits	1	1 = 80	Showing incidence of revenue from country spirits on population.
Do. Registration	1	1 = 80	Showing percentage of registration.
Do. do.	1	1 = 80	Showing position of registration offices.
Punjab, Income Tax	1	1 = 80	Showing distribution by districts.
Do. do.	1	1 = 80	Showing incidence by districts.
Madras, Excise	1	1 = 80	Prepared for C. E. Buckland, Esq., on special duty.
Bombay and Sind, Excise	1	1 = 80	
Country round Jalna	2	1 = 1	For Camp of Exercise.
Ditto Secunderabad	2	1 = 1	Ditto.
India, Railway Feeders	6	1 = 32	Brought up to date.
Projection of graticules and trigonometrical points of sheets of Burma.	40	...	Prepared for use of Quartermaster General's Department.

DRAWING OFFICE, CALCUTTA.

SECTION I.

Statement of work—concluded.

Description of Work.	Number of Sheets.
Maps examined.	
Atlas sheets	52
General maps	16
Provincial maps	10
Divisional maps	9
District maps	12
Standard maps	71
Plans of Cities, Cantonments, &c.	17
Index maps	7
Statistical maps	77
Triangulation charts	1
Miscellaneous maps	1
Maps prepared for other departments	6
Engraved proofs of General and Provincial maps	36
Engraved proofs of Atlas sheets in various stages	196
Lithographic proofs of General and Provincial maps, including Index charts	33
Lithographic proofs of Atlas sheets and District maps transferred from copper-plates	22
Lithographic proofs of Extra-Departmental and Statistical maps	16
Photographic proofs of Standard sheets, large scale Plans, and various other Maps	231
Colouring of maps for office use	38
Projection and examination of graticules and plotting of points	38
Total	889

N.B.—In addition to the above, many miscellaneous jobs, such as tracings of charts, supply of geographical data to various officials, calculation of areas, computation of graticules for the projection of the sheets of the Indian Atlas, examination of the proof sheets of Survey of India Notes and of Narrative Reports of Survey Parties as to the correct orthography of names, &c., have been performed by the Examining Section.

DRAWING OFFICE, CALCUTTA.

SECTION II.—REVENUE.

Statement showing the work performed during the year 1887-88.

TITLE.	Number of Sheets.	Scale.	REMARKS.
		In. M.	
STANDARD MAPS.			
Punjab—			
District Hissar.			
Sheets 241 and 242 . . .	2	1 = 1	Proofs examined and sent to press.
Sheet 256	1	1 = 1	Publication deferred pending insertion of canals from Executive Officer.
Sheet 261	1	1 = 1	Final press order given.
District Rawalpindi.			
Sheets 160 ($\frac{N.E.}{2,3,4}$, $\frac{S.E.}{1,2,3,4}$), 161 ($\frac{N.E.}{1,2,3}$, $\frac{S.E.}{2,3,4}$), 162 ($\frac{N.E.}{1,2,3,4}$), 183 ($\frac{S.W.}{3}$), 185 ($\frac{S.W.}{2,3,4}$, $\frac{S.E.}{1,2,3,4}$).	25	4 = 1	Forest boundaries having been settled, the originals were corrected from proofs received from Forest Department and passed with final press order.
Sheets 161 ($\frac{N.E.}{4}$, $\frac{S.E.}{1}$), 184 ($\frac{N.W.}{1,3,4}$, $\frac{S.W.}{1,2,3,4}$).	9	4 = 1	Originals examined and sent to press.
Sheets 185 ($\frac{N.W.}{1,2,3}$, $\frac{S.W.}{1}$) .	4	4 = 1	First proof examined and sent to press.
Districts Jullundur, Ludhiana, Hoshiarpur and Umballa.			
Sheet 253	1	1 = 1	Completed up to margin. First proof examined and sent to press.
Sheets 266, 267, 269, 270, 289, 290, 291, 292, 313, 314 and 336.	11	1 = 1	Examined and sent to press.
District Hazara.			
Sheets 11, 14 and 15 . .	3	1 = 1	First proof examined and sent to press; for replenishing stock.
North-Western Provinces—			
District Aligarh.			
Sheet 23	1	1 = 1	Margins completed. Villages and other names corrected in accordance with list of names received from Executive Officer; sent to press.
Sheets 36, 52 and 53 . . .	3	1 = 1	Village and other names are under correction in accordance with list of names received from Executive Officer.
Sheet 37	1	1 = 1	Final press order given.
Sheets 36 (N.E., S.E.) . .	2	2 = 1	Village and other names corrected; sent to press.
Sheets 36 ($\frac{N.W., N.E.}{S.W., S.E.}$), 37 (N.W.), 52 ($\frac{N.W., N.E.}{S.W., S.E.}$), and 53 ($\frac{N.W., N.E.}{S.W., S.E.}$).	13	2 = 1	Village and other names are being corrected in accordance with list of names received from Executive Officer.
District Gorakhpur.			
Sheets 216 and 217 . . .	2	1 = 1	Drawn, completed and sent to press.
District Basti.			
Sheet 162	1	1 = 1	The N. E. and S. E. sections have been completed up to margin from the 4" Sheets of the Oudh Survey and sent to press for a preliminary edition.
District Mirzapur.			
Sheets 169, 170 and 171 . .	3	1 = 1	Drawing completed; sent to press. Foot-notes and margins of No. 171 have been completed.
Sheet 182	1	1 = 1	Under examination.

DRAWING OFFICE, CALCUTTA.

SECTION II.

Statement of work—continued:

TITLE.	Number of Sheets.	Scale.	REMARKS.
STANDARD MAPS—*contd.*		In. M.	
Oudh—			
Sheets 102, 104, 117 and 118 .	4	1 = 1	Final press order given.
Sheets 100, 101 and 103 . .	3	1 = 1	Sent to press for correction.
Sheets 114, 115, 147, 148, 152, 172 and 174.	7	1 = 1	Proofs have been received from press and sent to District Officer for examination.
Bengal—			
District Cuttack.			
Sheet 194 and 195 . . .	2	1 = 1	Under examination.
Sheet 196	1	1 = 1	Sent to press.
District Mymensingh.			
Sheets 343 and 345 . . .	2	1 = 1	Proofs sent to District Officer for examination.
Sheets 344 and 364 . . .	2	1 = 1	Proofs examined and sent to press.
Sheets 346 and 362 . . .	2	1 = 1	First proofs examined with originals.
District Tipperah.			
Maps of main circuits Nos. 4, 5, 6, 7, 11 and 12 . . .	6	1 = 1	Lithographic prints reproduced by photozincography to replenish stock. Passed with final press order.
District Dacca.			
Maps of main circuits Nos. 3, 4, 5, 6, 7, 8, 9, 13 and 14 . .	9	1 = 1	Ditto ditto.
District Bogra.			
Pargana maps Nos. 3, 4, 6 and 8	4	1 = 1	Ditto ditto.
District Pubna.			
Pargana maps Nos. 3 and 4 .	2	1 = 1	Ditto ditto.
District 24-Pergunnahs.			
Sheet No. 3	1	1 = 1	Ditto ditto.
Bombay—			
Sheet No. 160	1	1 = 1	Examined; publication deferred until the portion of Dharampor State is surveyed, when it will be sent to the field party for completion.
Sheets Nos. 191, 199, 227 and 260	4	1 = 1	Original corrected and passed with final press order. For replenishing stock.
Sheets Nos. 134, 168, 172, 173, 204, 275 and 276 . . .	7	1 = 1	Press order given.
Sheet No. 243	1	1 = 1	Examined, corrected and sent to press.
Burma (Lower)—			
Sheets Nos. 141 and 231 . .	2	1 = 1	Proofs examined and final press order given.
„ „ 143, 232 and 233 .	3	1 = 1	Drawn, examined and passed with final press order.
„ „ 142, 187 and 281 .	3	1 = 1	In hand.
„ „ 230 and 278 . .	2	1 = 1	Being incorporated with the Burma Forest Survey 2″ Sheets.
PLANS OF CITIES AND CANTONMENTS.			
Benares City including Sikraul and Pandipur Cantonments .	4	8 = 1	Being drawn on the 16-inch scale for reduction to 8″=1 mile.

DRAWING OFFICE, CALCUTTA.

SECTION II.

Statement of work—continued.

TITLE.	Number of Sheets.	Scale.	REMARKS.
STANDARD MAPS—*contd.*			
Work done for other Departments.			
General plan of Lucknow. Military map	...	1″=800 ft.	Passed with final press order.
Map No. 1. Paper No. 6 C. Map No. 2. Country of Akhal, Teke and Merv Oasis. Paper No. 6 D. Route Section of Persia from Enselle on Caspian through Kasain, Teheran, Shiraz to Bushire on Persian Gulf. Paper No. 7 C. Rough Section along high road from Shiraz to Karman, Banpur and Salk of the edge of the Kharian or Helmund desert. No. 7 D. Plan of the Georgian Military road. Paper No. 7 A.		Various Scales.	Specially prepared for Colonel LeMessurier, R.E. Passed with final press order.
INDEX MAPS.			
Survey operations in the Punjab.	...	...	Corrected, brought up to date and sent to press.
Do. South Maratha Country.	...	...	Ditto.
Do. of the Town of Calcutta.	...	...	Ditto.
Cadastral Survey in District Bilaspur	...	...	Ditto.
Cadastral Survey in District Basti	...	...	Ditto.
Cadastral Survey in District Gorakhpur	...	...	Ditto.
Cadastral Survey in District Tarai	...	...	Ditto.
Cadastral Survey in District Kamrup	...	...	Ditto.
Cadastral Survey in District Darrang	...	...	Ditto.
Cadastral Survey in District Nowgong	...	...	Ditto.
Cadastral Survey in District Bassein	...	...	Ditto.
Cadastral Survey in District Thongwa	...	...	Ditto.
Cadastral Survey in Angul Government Estate	...	...	Ditto.
Cadastral Survey in Sankarpur Estate	...	...	Ditto.
Cadastral and Traverse Survey in District Raipur	...	...	Ditto.
Traverse Survey in Districts Nagpur and Wardha	...	...	Ditto.
Traverse Survey in Districts Jubbulpore and Damoh	...	...	Ditto.
Traverse Survey in Districts Seoni and Chhindwara	...	...	Ditto.
Traverse Survey in Districts Saugor and Narsinghpur	...	...	Ditto.
Cadastral Survey in District Jhansi	...	...	Drawn and sent to press.
Cadastral Survey in District Sibsagar	...	...	Ditto.
Cadastral Survey in Banki Government Estate	...	...	Ditto.
Cadastral Survey in Kujang Estate	...	...	Ditto.
Cadastral Survey in Maldwar Estate	...	...	Ditto.
Traverse Survey in Districts Hoshangabad and Betul	...	...	Ditto.
Traverse Survey in Srinagar Estate	...	...	Ditto.
PROOFS EXAMINED.			
Photo-zincographed maps	266		
Lithographed maps	50		

DRAWING OFFICE, CALCUTTA.

SECTION II.

Statement of work—continued.

DESCRIPTION OF WORK.	REMARKS.
Computations examined.	
District Basti, Seasons 1885-87	Report remains to be submitted.
Traverse data, &c., supplied.	
Main Circuit, No. 6, 6A, 8, 10, &c., District Hamirpur along Jhansi.	For Col. J. E. Sandeman, Deputy Superintendent of Survey.
Main Circuits, Nos. 4 and 8, District Seoni along Chhindwara.	For Deputy Commissioner.
District Henzada along Thongwa	For F. W. Kelly, Esq., Deputy Superintendent of Survey.
Districts Jacobabad, Larkhana and Mehar along Baluchistan.	For Captain F. B. Longe, R.E., Deputy Superintendent of Survey.
Killah Khorda along Killah Banki (21 pages)	For Col. Barron, Deputy Superintendent of Survey.
From origin of Hamirpur to Jhansi boundary with connections to G. T. S. points.	For Col. J. E. Sandeman, Deputy Superintendent of Survey.
Boundary between Sialkot and Jummoo territory .	For Deputy Commissioner.
Main Circuit No. 3, Ganges River Circuit, No. 2, and 19 villages of Main Circuit, No. 2, District Furreedpore (20 pages.)	For Collector of Furreedpore.
Government Forest Reserves, Ahiri Zamindari, District Chanda (50 pages.)	For Superintendent, Forest Surveys.
Main Circuit, No. 14, District Dacca (7 pages) .	For Collector of Fureedpore.
7 Villages	For Collector of Gorakhpore.
5 „	For Collector of Sarun.
11 „	For Collector of Maldah.
11 Villages, Ganges River Survey . . .	For Collector of Maldah.
8 Villages	For Collector of Bhagalpur.
6 „	For Collector of Pubna.
Triangulation data, with lats. and longs., District Nagpur.	For Col. Wilkins, Deputy Superintendent of Survey.
Triangulation data of the Black Mountain . .	For Captain Wahab, R.E., Deputy Superintendent of Survey.
„ Sind along Baluchistan . .	For Captain Longe, R.E., Deputy Superintendent of Survey.
Field Book of the Boundary between Sialkot and Jummoo.	For Deputy Commissioner.
Rectangular co-ordinates of points on the Black Mountain.	For Captain Wahab, R.E., Deputy Superintendent of Survey.
Values and description of Level Bench-marks from Rangoon *vid* Tunte and Maubin, &c., to Henzada.	For Executive Engineer, Bassein Division.
Values and description of Levelling Bench-marks from Henzada to Taboo.	For Executive Engineer, Bassein Division.
Values and description of Level Bench-marks in and around Elephant Point.	For Deputy Commissioner.
Miscellaneous.	
Computation and plotting of a group of Malda villages for a congregated village map.	For the Collector of Maldah.
Computation and plotting of a group of villages .	For the Collector of Pubna.
Computation and plotting of a group of villages of Killah Banki.	For Col. W. Barron, Deputy Superintendent of Survey.
Computation and plotting of 19 villages of Furreedpore for incorporation with 2″ map.	
Calculation of latitudes, longitudes and azimuths of all triangulated stations of Captain Samuells' survey of District Lakhimpur.	For Mr. Ogle, Surveyor.
Latitudes and longitudes of Black Mountain points .	For Captain Wahab, R.E., Deputy Superintendent of Survey.

DRAWING OFFICE, CALCUTTA.

SECTION II.

Statement of work—continued.

DESCRIPTION OF WORK.	Scale.	REMARKS.
	In. M.	
Miscellaneous—continued.		
Latitudes and longitudes for the projection of District Kheri and rectangular co-ordinates for the projection of Delhi and Hissar Divisions.		
Preparation of statement of limits of Districts in Bengal by latitudes and longitudes.		For Director of Statistics.
Calculation of areas by parganas of Sheets Nos. 18, 22, 35, 46, 47, 58, 61, 62, 62A, 64, 65, 70, 73, 75, 76, 77, 78, 80, 82, 84, 85, 86, 133, 159, and 270 Bombay; Sheets Nos. 37, 162, 181, 195, 196, 197 North-West Provinces, and of Sheet No. 253 Punjab for insertion on original maps.		
Calculation of area under cultivation according to circles in Sheets 123, 124, 125 and 126 Burma; also areas of the cantonments of Dagshai, Jutogh, Solon and Subathu.		
Preparation of area of District Gonda by Parganas and of District Darjeeling by Thanas.		
Preparation of Statements for Annual Report, &c.		
Tracings.		
Sheets Nos. 60, 61, 68 and 69, District Karnal.	4=1	For Executive Engineer, Western Jumna Canal.
Extract from Triangulation Chart of Chhatisgarh Division, Central Provinces.	1=4	For G. B. Scott, Esq., Assistant Superintendent of Survey.
District Rohri of Sind along Bahawalpur State.	2=1	For Superintendent, Sind Survey.
Village plan of Gosalpur, District Jubbulpore.	4=1	For Director, Geological Survey.
101 village plans of Killa Banki, District Cuttack.	...	For Collector of Cuttack.
28 village plans of Pargana Chynepur, District Shahabad, with an Index.	4=1	For Colonel Cowan, Deputy Superintendent of Survey.
1 village plan of District Bhagalpur.	4=1	For Collector.
2 village plans, Ganges Deara Survey.	4=1	For Collector of Sarun.
6 Forest Blocks and 2 villages of District Gorakhpur.	4=1	For Conservator of Forests, North-Western Provinces and Oudh.
3 Reserved Forest tracts in Tahsil Bijeraghogarh, District Jubbulpore, in triplicate.	4=1	For Superintendent, Forest Surveys.
7 villages of District Dacca	4=1 2=1	For Collector, Furreedpore.
Village plan of Pargana Haveli, District Gorakhpur.	4=1	For Conservator of Forests, North-Western Provinces and Oudh.
Sheets Nos. 4 and 13, Ganges Deara Survey.	4=1	For Executive Engineer, Eastern Bengal State Railway.

DRAWING OFFICE, CALCUTTA.

SECTION II.

Statement of work—continued.

DESCRIPTION OF WORK.	Scale.	REMARKS.
	In. M.	
Tracings—contd.		
Main Circuits 9,11 and 12 of Military Reconnaissance of District Chittagong (Chittagong Hill Tracts).	1=1 1=2	For Commissioner, Chittagong.
Village plan, Pargana Berahimpur, District Pubna.	4=1	For Deputy Collector, Kooshtea.
Dhaneshoari Ghoroni Estate in Mauza Hawli Mohonpur, District Darrang.	8=1	For E. C. Barrett, Esq., Deputy Superintendent of Survey.
Portions of Sheets Nos. 13, 14, 20 and 21, Lower Provinces, Survey Districts Dacca and Furreedpore.	4=1	For Collector, Pubna.
Sheet No. 77, N. E. and S. E., Lower Burma, showing about 1 mile of overlap along unsurveyed gap.	2=1	For Major M. G. Talbot, R. E.
Map of Central Provinces, showing the different scales of survey.	1=16	For Superintendent, Forest Survey.
Portion of Sheet No. 233, Lower Burma Survey.	2=1	For F. W. Kelly, Esq., Deputy Superintendent of Survey.
Sheets Nos. 54 and 55 of Pargana Manikapur, and 54, 55, 56 and 57 of Pargana Nawabganj, District Gonda (in duplicate).	4=1	For Conservator of Forests, North-Western Provinces and Oudh.
4 village plans of Pargana Mah, 28 of Pargana Kiwai, District Allahabad.	4=1	For Deputy Surveyor General, Trigonometrical Branch.
Overlap of 1 mile of District Jaunpur along boundary of Mirzapur in Sheets Nos. 167 S. E. and 181 N. W.	2=1	
Killahs Kujang, Bishenpur and Harichpur, District Cuttack.	1=1	For Colonel Barron, Deputy Superintendent of Surveys.
7 villages of District Dinagepore belonging to Sankarpur Estate.	4=1	For ditto ditto.
Village plan of Pargana Khirni, District Beerbhoom.	4=1	For Deputy Collector, Dumka.
Portions of Sheets Nos. 12, 15, 16 and 17, Main Circuit Nos. 1 and 22, District Furreedpore.	4=1	For Superintendent, Ways and Works, Eastern Bengal State Railways.
Sheet No. 20 of Main Circuit No. 21, District Jubbulpore.	4=1	For Superintendent, Forest Survey.
Portions of Sheets Nos. 2, 3 and 8, Main Circuit 1 and 3, Ahiri Zamindari, District Chanda.	2=1	Ditto. Ditto.
Portions of Sheets Nos. 24, 30 and 31, Deara Survey.	4=1	For Superintendent, Ways and Works, Eastern Bengal State Railway.
5 villages, Pargana Haveli, District Purneah.	4=1	For District Engineer, Purneah.
10 village plans and 2 traces of Pargana Kankjaul, District Maldah.	4=1	For Collector of Maldah.
Portion of Sheet No. 4, Main Circuit No. 10, Ganges River Survey.	...	For Collector of Patna.
Balrampur reserved forest, District Gonda.	4=1	For Conservator of Forests, Oudh Circle.
Village plan of Pargana Begamabad, District Nuddea.	4=1	For Collector.

DRAWING OFFICE, CALCUTTA.

SECTION II.

Statement of work—continued.

DESCRIPTION OF WORK.	Scale.	REMARKS.
	In. M.	
Tracings—contd.		
6 village plans, Pargana Kubkund, District Bhagalpur.	4=1	For Collector.
Congregated plan of 19 villages, Pargana Kankjaul, District Maldah, showing old survey and Ganges Deara Survey.	4=1	For Deputy Collector.
Harcharampur and adjoining villages, Parganas Jamuria and Chundipur, District Maldah.	4=1 2=1	For Collector.
2 village plans of Pargana Behar, District Patna.	4=1	For Sub-Division Office.
Compiled plan of 14 villages of Killah Banki, District Pooree.	4=1	For Colonel Barron, Deputy Superintendent of Survey.
Congregated plan of 8 villages of Pargana Sonabaju, District Pubna.	4=1	For Collector.
Portions of Sheets Nos. 15, 16 and 17, District Furreedpore.	4=1	Ditto.
Sheets Nos. 30 and 31, Main Circuit No. 3, Ganges River Circuit No. with which was combined a reduced plan of Sheets Nos. 15, 16 and 17 of District Furreedpore.	2=1	Ditto.
Mouza Garden Reach, 24-Pergunnahs.	4=1	Ditto.
Sheets Nos. 30 and 31, Main Circuit No. 3, Ganges Circuit No. 2, District Furreedpore.	2=1	Ditto.
Sheets Nos. 22, 23 and 24, District Chanda, and Sheet No. 7, District Bhandara.	4=1	For Mr. F. Grant, Surveyor.
Ten Skeletons including portions of Districts Mooltan, Jhang, Montgomery and Lahore.	1=1	For No. 1 Party.
Portion of map of District Hamirpur.	1=4	For Collector.
Portion of map of Adegaon Jagir, District Seoni.	4=1	For Assistant Settlement Officer.
Main Circuit maps of Nos. 11 and 12, District Chittagong.	1=1	
Two villages of District Damoh	4=1	For Settlement Officer.
Three plans of Kidderpore Dockyard.	..	For Marine Survey Office.
Portions of Sheets No. 179 and 180, boundary between Sialkot and Jummoo.	2=1 4=1	For No. 20 Party (Burma Forest). For No. 1 Party (Punjab).
Boundary between Dang State and District Nasik.	2=1	For No. 17 Party (Gujarat).
A portion of Sheet No. 227, District Prome.	2=1	For No. 20 Party (Burma Forest).
Four large maps including South Western and Southern portions of Bara Banki District, Western portion of Sitapur District and North-Western portion of District Fyzabad.	4=1	For Secretary to the Government, North-Western Provinces and Oudh.
Jogitila and Guragarh meridional series.	1=8	For No. 1 Party.
Assam Valley Triangulation Chart	...	For Mr. Ogle, Surveyor.

DRAWING OFFICE, CALCUTTA.

SECTION II.

Statement of work—concluded.

DESCRIPTION OF WORK.	Scale.	REMARKS.
	N. M.	
Tracings—concld.		
G. T. Charts on Baluchistan border.	...	For Captain Longe, Deputy Superintendent of Survey.
Hazara Triangulation Chart .	...	For Captain Wahab, Deputy Superintendent of Survey.
Nagpur Triangulation Chart .	...	For Colonel Wilkins, Deputy Superintendent of Survey.
Map colouring.	Number.	
Maps on various scales . .	53	For Surveyor-General's Office.
Ditto ditto . .	53	For Deputy Surveyor-General's Office.
Ditto ditto . .	408	For India Office.

DRAWING OFFICE, CALCUTTA.

SECTION III.—CADASTRAL.

State of Publication of Cadastral Maps on the 30th September 1888.

DISTRICTS.	NUMBER OF SHEETS.							REMARKS.
	MAPS PREPARED.			PUBLISHED.				
	Up to 30th September 1887.	Added during past 12 months.	Total up to 30th September 1888.	Up to 30th September 1887.	By Surveyor General's Office during past 12 months	Total to 30th September 1888.	Remaining to be published.	
North-West Provinces.								
Agra	2,942	...	2,942	2,942	...	2,942	...	
Azamgarh	930	...	930	930	...	930	...	
Ballia	1,396(a)	...	1,396	1,394	2(c)	1,396	..	(a) Figures of previous return have been changed to agree with final results.
Banda	3,317	...	3,317	3,317	...	3,317	...	
Basti	4,545	880	5,425(b)	1,490	1,011	2,501	2,924	
Benares	1,884(a)	...	1,884	1,816	68(c)	1,884	...	
Bijnor	31	...	31	31	...	31	...	
Dehra Dun	701	...	701	651	48	699	2	(b) These figures are liable to alteration until publication has been completed.
Ghazipur	3,193(a)	...	3,193	3,050	143(c)	3,193	...	
Gorakhpur	4,872	3,555	8,427(b)	2,354	912	3,266	5,161	
Hamirpur	2,926	...	2,926	2,926	...	2,926	...	
Jaunpur	3,434	...	3,434	3,434	...	3,434	...	
Moradabad and Tarai	4,023	...	4,023	4,023	...	4,023	...	(c) These maps have been reprinted.
Muttra	1,658	...	1,658	1,658	...	1,658	...	
Mirzapur	3,646(a)	...	3,646(b)	3,638	1(c)	3,639	7	
Tarai	346	63	409(b)	346	...	346	63	
TOTAL	39,844	4,498	44,342	34,000	2,185	36,185	8,157	
Burma.								
Akyab	2,302	477	2,779(b)	1,309	1,033	2,342	437	
Bassein	3,076	280	3,356(b)	3,076	...	3,076	280	
Hanthawaddy and Pegu	4,601	...	4,601	4,601	...	4,601	...	
Henzada	1,391	...	1,391	1,391	...	1,391	...	
Prome	847	...	847	847	...	847	...	
Tharrawaddy	1,363	...	1,363	1,363	...	1,363	...	
TOTAL	13,580	757	14,337	12,587	1,033	13,620	717	
Bengal.								
Patna and Gya	3,054	...	3,054	3,054	...	3,054	...	
Pooree (Khorda Estate)	4,565	...	4,565	4,565	...	4,565	...	
Shahabad	4,924	...	4,924	4,924	...	4,924	...	
Mozufferpore	1	...	1	1	...	1	...	
TOTAL	12,544	...	12,544	12,544	...	12,544	...	
Assam.								
Darrang	...	717	717	...	703	703	14(d)	(d) Not to be printed.
Kamrup	1,675	...	1,675	1,675	...	1,675	...	
Sylhet	61	...	61	16	...	16	45	
TOTAL	1,736	717	2,453	1,691	703	2,394	59	
Central Provinces.								
Raipur	43	...	43	43	...	43	...	
TOTAL	43	...	43	43	...	43	...	
GRAND TOTAL	67,747	5,972	73,719	60,865	3,921	64,786	8,933	

Abstract of work performed during 1887-88.

PROVINCE.	NUMBER OF SHEETS.				REMARKS.
	Examined and rendered suitable for photo-zincography.	Traced and examined for zincography.	Proof copies examined previous to press order.	Coloured and subsequently examined.	
North-West Provinces	1,480	450	2,087	2,185	Scale 16 inches = 1 mile.
Burma	994	239	1,067	1,033	Ditto ditto.
Bengal	...	...	...	...	Ditto ditto.
Assam	463	240	703	...	Ditto ditto.
TOTAL	2,937	929	3,857	3,218	

ENGRAVING OFFICE, CALCUTTA.

Statement showing the work performed during the year 1887-88.

Title of Map.	Outline, Square inches.	Number of letters cut.	Hills (H) and Sand (S). Square inches.	Remarks.
Indian Atlas.				
Scale 1 inch = 4 miles.				
Quarter sheets (new), completed.				
16 N. W.	...	12,000	...	Completed to margin.
16 S. W.	...	1,947	...	Completed as far as survey; small portion of desert left blank.
19 S. E.	...	235	7 H.	Completed to margin.
23 S. E.	...	288	8 H.	Completed as far as survey; small portion of desert left blank.
39 N. W.	...	973	20 H.	Completed to margin.
39 S. E.	10	1,290	22 H.	
114 S. E.	...	1,344	13 H.	
Total	10	18,077	70 H.	
Quarter sheets (new), in progress.				
11 S. E.	55	3,276	...	Additional outline engraved; writing almost completed.
11 S. W.	...	3,050	...	Writing almost completed.
12 N. E.	...	...	2 S.	Slight additions to sand hills.
14 N. E.	22	1,114	...	Additional outline and writing engraved.
14 S. E.	5	752	4 S.	Corrections to outline and writing.
14 S. W.	50	1,448	...	Outline and writing completed as far as material supplied.
15 N. W.	...	81	57 H.	Slight additions to writing completed; hills in progress.
21 N. W.	30	950	...	Border divided; outline and writing completed as far as material supplied. Outside figures in progress.
21 S. E.	32	...	...	Additional outline in progress.
21 S. W.	60	2,189	...	Outline and writing completed as far as material supplied.
22 N. E.	...	3,279	...	Additional writing completed.
22 N. W.	22	1,834	...	Outline and writing completed.
23 N. E.	35	1,847	...	Additional writing and waterline completed.
24 N. E.	46	782	...	Border cut. Outline completed as far as material supplied, outside figures in progress.
27a S. W.	...	1,055	...	Outline and writing completed as far as material supplied.
28 S. E. Duplicate	...	3,045	...	Additional writing completed.
31 N. E.	...	...	...	Reprojected and border cut.
35 S. W.	53	2,565	...	Lakes shaded, outline and writing completed as far as material supplied.
36 N. W.	95	5,515	...	Outline and writing completed as far as material supplied.
36 S. W.	24	4,126	53H.	Reprojected, border cut, outline finished as far as material supplied, writing in progress.
37 N. W.	27	4,276	...	Outline and writing completed as far as material supplied.
37 S. W.	37	2,490	...	Ditto ditto.
38 N. E.	...	...	71 H.	Hills completed as far as material supplied.
38 N. W.	14	1,646	...	Additional outline and writing engraved as far as material supplied.
39 N. E.	...	2,713	...	Writing well advanced, in progress.
40 N. W.	...	4,300	...	Writing in progress.
42 S. E.	110	11,606	62 H.	Outline and writing completed to margin. Hills in progress.
43 N. E.	...	...	43 H.	Hills in progress.
Carried over	717	63,939	286 H. 6 S.	

ENGRAVING OFFICE, CALCUTTA.

Statement of work—continued.

Title of Map.	Outline. Square inches.	Number of letters cut.	Hills (H) and Sand (S). Square inches.	Remarks.
INDIAN ATLAS.				
Scale 1 inch = 4 miles.				
Quarter sheets (new), in progress—continued.				
Brought forward .	717	63,939	286 H. 6 S.	
48 N. E.	5	195	21 H.	Heavy corrections. Large portion cleaned off. Portion of border re-cut. Hills in progress.
49 S. W.	3	145	19H. 6 S.	Additional outline and writing completed. Sandhills in progress.
50 N. W.	30	19,211	...	Outline and writing completed as far as material supplied.
50 S. E.	...	115	...	Outline and writing completed to margin. Hills about to be put in hand.
57 N. W.	46	7,496	...	Outline and writing completed as far as material supplied.
57 S. W.	...	1,419	...	
59 N. W.	...	5,010	...	
59 S. E.	9	10,606	...	
59 S. W.	...	13,762	...	Writing completed to margin; awaiting hill drawing.
60 N. E.	...	5,911	...	Writing completed to margin. Lakes shaded, hills about to be gone on with.
60 N. W.	...	2,313	157H.	Corrections to writing completed. Hills well advanced, in progress.
60 S. E.	...	3,398	...	Outline writing completed to margin; awaiting hill drawing.
60 S. W.	...	13,164	...	Outline and writing completed as far as material supplied.
61 N. W.	...	5,459	...	Writing in progress.
68 N. W.	...	100	...	Do. do.
69 N. E.	...	281	...	Slight additions to writing.
75 S. E.	...	3,361	...	Writing in progress.
76 S. W.	...	220	...	Slight additions to writing.
77 S. W.	3	1,110	...	Reprojected, border cut, outline and writing completed as far as material supplied.
78 N. E.	18	2,288	...	Additional outline, writing, and water-lining cut; awaiting hill drawing.
78 N. W.	...	9,462	...	Writing in progress.
78 S. W.	...	12,655	...	Do. do.
88 N. E.	31	5,823	...	Outline and writing completed as far as material supplied.
88 S. E.	38	1,597	...	Additional outline engraved as far as material supplied, writing in progress.
103 N. E.	12	2,182	...	Outline and writing completed as far as material supplied.
103 N. W.	64	1,872	...	Outline completed as far as material supplied. Writing in progress.
103 S. W.	2	...	...	Slight corrections to outline.
114 S. W.	...	64	50H.	Hills almost completed as far as material supplied, in progress.
125 S. E.	...	9,538	...	Outline and writing completed to margin and awaiting hill drawing.
TOTAL .	978	202,696	533H. 12 S.	
Additions and corrections to published Quarter Sheets.				
1 N. E.	...	227	...	Foot-note cut.
1 S. E.	...	227	...	
12 N. W.	...	332	12 H.	Additions and corrections completed.
32 S. E.	...	417	2 S.	
Carried over .		1,203	12 H. 2 S.	

ENGRAVING OFFICE, CALCUTTA.

Statement of work—continued.

Title of Map.	Outline. Square inches.	Number of letters cut.	Hills (H) and Sand (S). Square inches.	Remarks.
Indian Atlas. Scale, 1 inch = 4 miles. *Additions and corrections to published Quarter Sheets*—continued.				
Brought forward .	...	1,203	12 H. 2 S.	
33 N. E.	...	157	2 S.	Slight additions and corrections of writing completed.
33 N. W.	...	400	...	Footnote cut and slight additions completed.
34 N. E.	...	93	...	Slight corrections completed.
34 N. W.	2	329	...	Additions and corrections to outline and writing completed.
34 S. E.	...	131	...	
34 S. W.	...	1,213	...	
35 N. E.	...	334	...	Additions to writing completed.
35 N. W.	...	...	...	Slight corrections to outline completed.
37 N. E.	...	68	...	Slight corrections to writing completed.
38 S. W.	...	2,161	10 H.	Heavy additions and corrections to names and heights completed.
39 S. W.	...	469	...	Additions to writing carried out on the duplicate plate.
49 S. E.	1	741	...	Slight additions to outline and writing completed.
50 N. E.	...	40	...	Slight additions completed.
51 N. E.	...	177	...	Ditto ditto.
52 S. W.	...	548	...	Ditto ditto.
53 S. E.	2	1,563	12 H.	Additions and corrections to outline, writing and hills completed.
53 S. W.	...	119	...	Slight additions to writing completed.
66 N. E.	...	306	...	Additions and corrections to writing completed.
70 N. E.	...	2,180	...	Additions and corrections to district names, title and footnote completed.
70 S. E.	...	2,569	...	Additions and corrections completed.
70 S. W.	...	42	...	Slight corrections to writing completed.
71 N. E.	...	3,548	...	Additions and corrections to writing completed.
71 N. W.	...	825	...	Slight corrections to district names completed.
71 S. W.	...	808	...	Additions and corrections to writing and railways completed.
90 N. E.	...	659	3 H.	Additions and corrections to district names, title and footnote completed.
90 N. W.	...	377	...	Additions and corrections to writing completed.
90 S. E.	...	1,300	...	Additions and corrections to district names completed.
91 N. E.	...	35	...	Slight additions completed.
91 S. E.	...	841	...	Additions and corrections to writing engraved.
92 N. E.	...	250	...	Slight corrections to district names completed.
92 N. W.	...	16	...	
105 N. W.	...	449	...	Additions and corrections to district names, title and footnote engraved.
105 S. E.	...	362	...	
105 S. W.	...	552	...	
125 N. W.	...	42	...	Slight additions to writing completed.
125 S. W.	3	1,664	4H.	Additions and corrections to railways and names completed.
126 N. W.	...	50	...	Slight additions to writing completed.
126 S. E.	12	951	...	Additions and corrections to outline and writing completed.
126 S. W.	...	877	.4	Additions and corrections to writing engraved.
Total .	20	28,449	41H. 4S.	

ENGRAVING OFFICE, CALCUTTA.

Statement of work—continued.

Title of Map.	Outline. Square inches.	Number of letters cut.	Hills (H) and Sand (S). Square inches.	Remarks.
Indian Atlas.				
Scale, 1 inch = 4 miles.				
Additions and Corrections to published Full Sheets.				
27	...	...	20H.	Hills repaired, completed.
40	...	...	65H.	Hills being repaired, in progress.
44	...	...	92H.	Hills repaired, completed.
47	...	...	256H.	Hills being repaired, almost completed, in progress.
54	5	50	...	Slight corrections to outline and writing completed.
63	...	...	102H.	Hills being repaired, in progress.
65	...	3,000	18H.	Hills repaired, writing being re-cut, in progress.
75	...	60	...	Slight corrections to boundary names.
89	...	104	...	Additions and corrections completed.
94	5	1,962	...	Heavy additions and corrections to boundaries, roads, and district names completed.
102	...	...	...	Slight corrections completed.
104	20	500	...	Heavy additions and corrections to boundaries, roads, and district name in progress.
Total	30	5,676	553H.	
New plates projected and border cut, &c.				
5 N. E.				Borders cut.
11 N. E.				
30 N. W.				
30 S. W.				
42 N. W.				
42 S. W.	...	...	...	
47 N. E.				
47 N. W.				
47 S. E.				
57 N. E.				
63 N. W.	...	...	...	Re-projected.
63 S. E.				
75 N. W.	...	...	...	Borders cut.
75 S. W.				
102 N. E.	...	...	...	Re-projected and border cut.
102 N. W.	...	92	...	Re-projected, border and portion of outside lettering cut.
102 S. E.	...	...	...	Re-projected, and border cut.
102 S. W.	...	92	...	Re-projected, border and portion of outside lettering cut.
Total	...	184	...	

ENGRAVING OFFICE, CALCUTTA.

Statement of work—continued.

Title of Map.	Number of sheets.	Outline. Square inches.	Number of Letters cut.	Hills (H) and Sand (S.) Square inches.	Remarks.
General Maps.					
India (1 inch = 32 miles)	8	...	...	...	.....
Sheet 2 Original	...	...	...	4 H.	Hills engraved.
„ 3 Do.	...	...	3,087	56 H.	Outline, writing and hills completed as far as material supplied.
„ 1 Matrix	...	...	...	...	Hills erased.
„ 4 Do.	...	...	...	...	Do.
„ 5 Do.	...	...	...	...	Do.
„ 6 Do.	...	...	...	...	Do.
„ 1 Outline	...	108	...	...	Outline re-cut where obliterated through removal of hills.
„ 4 Do.	...	266	3,587	...	Do. do.
„ 5 Do.	...	150	6,564	...	Do. do.
„ 6 Do.	...	38	1,503	...	Outline re-cut where obliterated through removal of hills; and Andaman Islands New Survey engraved.
India (1 inch = 80 miles)	2	...	1,356	...	Additions and corrections to railways and names completed.
India (1 inch = 256 miles)	1	...	...	...	Projected, a new plate.
Total	...	562	16,097	60 H.	
Provincial Maps. Scale 1 inch = 16 miles.)					
Assam	1	23	894	8 H.	Additions and corrections to outline and writing completed.
Bengal	2	...	4,000	...	Projected; title, imprint and outside figures cut; a new plate.
Bengal	2	20	3,726	...	Additions and corrections to outline and writing on old plate completed.
Central Provinces	2	...	...	...	Additions and corrections to railways completed.
Gujarat	1	75	...	...	Border cut, outline engraved as far as material supplied.
Mysore	1	30	1,445	...	Additional outline, title and scale cut. Writing in progress.
North-Western Provinces and Oudh.	2	130	...	...	Outline in progress.
Punjab	4	...	4,926	...	Writing on one sheet almost completed, in progress.
Administration Report Maps. Scale 1 inch = 80 miles.					
Bengal	1	8	3,328	...	Outline, writing and water-lining completed.
Bengal (electro-type duplicate)	1	23	...	...	Corrections to outline completed.
Bengal (skeleton duplicate)	1	25	...	...	Do. do.
North-Western Provinces and Oudh.	1	...	100	...	Additional writing cut.
North-Western Provinces and Oudh (electro-type duplicate.)	1	32	...	...	Additions and corrections to outline completed.
Index Maps.					
Index to Indian Atlas	1	27	...	...	Outline engraved; writing about to be gone on with; a new plate.
Carried over	...	393	18,419	8 H.	

ENGRAVING OFFICE, CALCUTTA.

Statement of work—concluded.

Title of Map.	Number of sheets.	Outline. Square inches.	Number of letters cut.	Hills (H) and Sand (S). Square inches.	Remarks.
INDEX MAPS—continued.					
Brought forward .	...	393	18,419	8 H.	
Chart to Great Trigonometrical Survey	1	...	286	...	Additions and corrections to outline and writing completed.
CHARTS.					
Weather Chart of India . .	1	...	...	...	Slight corrections to degree figures, sea tinted.
Weather Chartof India small, in outline	1	...	75	...	Slight corrections completed.
Weather Chart of Bengal . .	1	...	675	...	Additions and corrections to writing completed.
MISCELLANEOUS PLATES.					
Imprint plate	...	...	375	...	New imprint cut.
Map headings	...	....	464	...	Additional writing cut.
Strange's Zenith Sectors . .	...	...	1,700	...	Additions and corrections to letters, &c., completed.
Scale plate	...	...	1,034	...	Writing re-cut, with slight additions completed.
Scale of Gunter's chain . .	...	...	3,750	...	Fifteen scales on one plate cut and lettered completed.
Tint plate No. 19 . . .	...	...	86	...	Completed.
Do. No. 20 . . .	...	...	62	...	
Do. No. 21 . . .	...	...	62	...	
Vernier scales	...	...	75	...	One scale figured for Mathematical Instrument Office.
Heliogravure plates . .	...	...	14,541	...	Titles, scales and sectional ruling engraved to 28 plates for Photographic Office
Other small plates . . .	...	...	325	...	Miscellaneous writing cut.
TOTAL .	...	393	41,929	8H.	

Abstract of work.

Engraving.

	Plates.
Atlas sheets completed	7
Ditto in progress	57
Ditto repairs, corrections and additions to published plates .	55
Ditto projections engraved, borders cut, etc.	18
General maps	85
TOTAL .	222

Copper-plate printing.

Impressions taken	20,398
Proofs pulled	579
Transfers pulled	344
TOTAL .	21,321

Steel-facing.

	Plates.
Double elephant plates, steel-faced .	11
Ditto ditto, steel-removed .	9
Quarter sheets ditto, steel-faced .	47
Ditto ditto, steel-removed .	39
Miscellaneous plates, steel-faced .	87
Ditto, steel-removed .	18
TOTAL .	211

Square inches of hill etching . .	1,281
Ditto outline . . .	1,993
Number of letters engraved . . .	313,108

PHOTOGRAPHIC OFFICE, CALCUTTA.

Extract from the Narrative Report of LIEUTENANT-COLONEL J. WATERHOUSE, *Assistant Surveyor-General—Season 1887-88.*

OUTTURN.—Though there has been a falling-off in the zinc-printing for ordinary departmental work, the outturn in other respects has been generally in excess of last year, and the value of work done has also been more. The increase is most marked in the Heliogravure Section, in which the photo-etching process has been very largely developed during the year.

ORIGINAL SUBJECTS.—The total number of original maps and plans received for reproduction in the normal sections of the office was 1,470, against 1,185 of the preceding year. Of these 628 were departmental maps and 842 were received from other departments. In the cadastral sections 3,870 original sheets were received, of which 2,971 were reproduced by photozincography and 899 zincographed from tracings.

NEGATIVE SECTION.—During the year the number of negatives taken was 4,972, inclusive of reversed negatives and transparencies, of which 1,029 were of departmental maps, 972 of extra-departmental maps and plans, and 2,971 of cadastral maps. Mr. H. Haward has been in charge of the section throughout the year.

The processes employed in this section have remained much the same as last year. The method of intensifying with bromide of copper and nitrate of silver has now been definitely adopted in both the cadastral and normal sections with great advantage. The formula which has been found most suitable is—

Copper sulphate (saturated solution)	3,000 parts.
Potassium bromide	700 „

The copper solution is kept at saturation by placing crystals of the sulphate in a partition at the sides of the tray, and 20 to 30 parts of bromide of potassium are added as required. The plates are developed with iron in the ordinary way, but are not intensified, and after fixing and washing they are plunged into the copper solution and remain until they turn of an even pale yellow tint. They are then thoroughly washed and placed in a tray containing a solution of nitrate of silver at about 3 per cent.; after remaining in this bath one or two minutes they acquire full density and are removed and well washed.

A change has also been made in the use of hyposulphite of soda instead of cyanide of potassium for fixing. It is much cheaper, and free from the poisonous properties of cyanide of potassium.

PHOTO-TRANSFER SECTION.—The number of photo-transfers printed was 4,606, of which 1,653 were of departmental and extra-departmental maps, &c., and 2,953 of cadastral maps.

The method of preparing the photo-transfer paper with arrowroot has been followed for the cadastral maps, and, though sometimes rather troublesome in working, has given on the whole good results. For the fine office work, however, it has been found better to revert to gelatine, but it is now applied with a brush in a very thin coat, the gelatine solution being composed as follows:—

Gelatine	27 grammes.
Bichromate of potash	17 „
Water	450 millilitres.

After receiving one coat the paper is dried, then recoated, dried, and put away in a dark box for a few days to harden before use; but if not then required for immediate use, the bichromate is washed out of the paper, and the paper so treated can be kept for any length of time. It is recoated before use with a thin coat of gelatine solution containing double as much bichromate as above. This method of working has given very good results, and is far more economical in gelatine than the old method of floating the paper on the gelatine solution.

The necessity of introducing some system of accurately reproducing maps in two or more colours by photozincography has directed attention to the trial of methods of obtaining the photographic image direct on the zinc plates, instead of transferring it from paper prints, which must always be more or less untrue to scale—a defect which is increased when maps are photographed in several sections. Experiments in this direction were tried both by the asphaltum process, which will be described under the Heliogravure Section, and by the bichromate and gelatine method. Mr. Harrold, who is in charge of the section, has taken a good deal of pains in the matter, and has, at last, succeeded in finding what appears to be a very simple and efficient mode of working.

In this, as in all other methods of obtaining the photographic image directly upon the printing surface, a reversed negative is necessary, but this is easily produced by the aid of a silvered glass mirror. The zinc used must be in *thin* sheets, so that perfect contact may be obtained in the printing frame between the plate and negative. The plate is carefully cleaned and grained as usual, then washed over with a strong solution of gum and decoction of nut-galls, such as is used for etching the zinc plates after the photo-transfers have been laid down. This is allowed to dry and then washed off to remove all traces of gum.

The plate is then again dried and coated evenly and carefully, by means of a piece of cloth folded into a long pad, with a solution of

Arrowroot solution	. . . 40 c.c.	Arrowroot	. . . 20 grammes.
		Bichromate of potash	. . 9 "
		Water	. . . 700 c.c.
Bichromate of potash	. . . 5 grammes.		
Albumen solution	. . . 15 c.c	Albumen	. . . . } equal parts.
		Water	. . . . }

The coating left on the plate is exceedingly thin: the plate is dried off quickly at a moderate heat and is dry in a few minutes. It is then exposed under the reversed negative for about 6 minutes in the sun for an ordinary line negative. The plate is allowed to cool and soaked in cold water for about half an hour to remove the bichromate. The exposed surface is now carefully sponged to clear away all soluble or unaltered colloid matter remaining on it. After a good rinsing in clean water the plate is dried and inked with transfer ink, and in about 15 minutes, as soon as this is dry, it is cleaned off with turpentine. A few drops of water are sprinkled over the plate, and it is then wiped and rolled in with ordinary printing ink. The further application of the etching solution of gum and nut-galls seems unnecessary, except for cleaning the borders, but, in any case, it should not be applied till the plate has been properly rolled in.

A plate recently prepared in this way has stood well for nearly 700 copies of a very fine subject and far better than a transferred plate would have done.

Experiments have also been made in printing direct on zinc from positive transparencies, but they were not successful.

ZINC-PRINTING SECTION.—The number of plates printed off by the normal establishment during the year was 647, the number of pulls being 115,792, and of copies 141,993. The departmental work shows a decrease and the extra-departmental an increase.

In the cadastral section the total number of plates printed was 3,897, the number of pulls 121,921, and of copies 114,733. This shows an increase all round, though still below the former average. The methods and processes remained the same, and there are no changes to record. Mr. B. Mackenzie, the Head Zincographer, took furlough for two years from the 7th May 1888, and Mr. E. A. Lefranc was appointed to officiate in his place, so that he might gain experience. Mr. Watson retained charge of the cadastral work.

SILVER PRINTING SECTION.—The work of this section shows an increase over last year, the number of silver prints being 1,771 and of cyanotype prints 672. The former include a large number of photographs of Central Asia and Persia reproduced for Colonel A. LeMessurier, R.E., and the latter are chiefly reductions of standard sheets, &c., required for departmental use, which are now printed by cyanotype instead of silver printing.

At the request of the Department of Public Works, Bengal, experiments were made in the positive cyanotype process, by which direct copies in dark blue upon a white ground can be obtained from ordinary tracings on paper or vellum cloth. The whole of the experimental work was done by Mr. Pope, and the following method of preparing and using the paper was found to answer best.

The paper employed should be well-sized photographic paper. The ordinary Rives and Saxe papers are good, and that prepared by Messrs. Schleicher, and Schull, of Düren, specially for this process, and obtainable in rolls from Messrs. Treacher and Company, Bombay, is very convenient, because it can be cut up as required to any size. The sensitising solution with which the paper is coated may be made up in two different ways, the subsequent processes being the same whichever method is employed.

By the first method, which is recommended by Fisch (*La Photocopie*), the following two solutions are made up separately:—

(1)	Gum Arabic (best)	170 parts.
	Distilled water	650 "
(2)	Tartaric acid	40 "
	Distilled water	150 "

When the gum is perfectly dissolved, which is facilitated by first powdering it, strain the solution through muslin into a clean vessel; then add, constantly stirring, the tartaric acid solution. When they are thoroughly mixed, 100 to 120 parts of a solution of perchloride of iron at 45° Baumé (1,453 Sp. gr.) are added in the same way, very slowly and with constant stirring, after which the mixture should be set aside in a dark place for 24 hours. Distilled water is then added until the mixture shows a density of not more than 1,100 on the hydrometer. It is essential that the mixture of the different solutions be made in the order given above: If the perchloride of iron were poured direct into the gum solution, the latter would be immediately coagulated, or thrown down in a sticky, insoluble mass, which can only be brought back to a liquid state by adding an excess of tartaric acid solution; but when this latter is already present in the gum solution there is no fear of coagulation: the solution is of an orange yellow colour, and if kept carefully protected from light, it will keep good for a long time.

In the second method, which is recommended by Captain Pizzighelli of the Austrian Army, ammonio-citrate of iron is added to the gum solution instead of tartaric acid. The sensitising solution is liable to become very thick after standing a short time, in which state it is not easy to apply to the paper. Moreover, neither the solution nor the prepared paper have been found to keep for any length of time in this climate, and therefore the

first of the two methods appears most useful for adoption in this country. The paper prepared by this process will keep in good order for a long time, provided it be protected from damp and light.

The coating of the paper must be performed in a yellow light, or in a room kept almost dark. It is important that the coat should be as even and as free from streaks as possible. A variety of methods of applying it have been tried: the easiest and best is to float the paper on the solution in a shallow tray for a few moments, taking great care to avoid air-bubbles and to keep the back of the sheet from getting soiled with the solution, and then hang it up to dry at once in a drying-box heated by a stove. When dry, another coat is given, in the same way, and the paper then hung up by the opposite end, in order to equalise the coating as much as possible. Applying the solution with a brush is not to be recommended, as it is almost impossible to avoid streaks, especially when coating large sheets of paper. It is important that the paper should dry quickly, so that the solution may not sink into its substance.

The sensitised paper is exposed to light in an ordinary printing frame, the tracing being laid face downwards in the frame, and the paper over it, with the yellow or prepared side, in contact with the back of the tracing. The exposure varies according to the intensity of the light. In direct sunlight an exposure of 15 to 40 seconds is sufficient to effect the reduction of the iron salt from ferric to ferrous chloride, except in the parts protected by the lines. In the shade or dull light the exposure may be prolonged from 1 to 5 minutes; in rain 5 to 15 minutes, and in dull foggy weather it may require 15 to 30 minutes or longer. One soon learns to guess the proper exposure under ordinary conditions of working. It is important, however, that the exposure should be exactly right; and therefore, unless the exact time required is known from past experience, it is advisable to make use of the following simple test.

A few lines of varying thickness are traced on the edges of the drawing to be copied in the same ink as was used to make the drawing. Over these lines and between the drawing and the sensitised paper, are placed some slips of the same sensitive paper, about 1 inch wide, the ends of which protrude beyond the edges of the printing frame in such a way that each slip can be drawn out of the frame at will. To apply the test, expose the frame to full sunlight for a few seconds, then turn it over, to protect the sensitive paper from light, and withdraw one of the test-slips. Then immediately plunge the end of the slip which was inside the frame and under the black lines drawn on the edge of the drawing into the solution of ferrocyanide of potassium used for developing, and watch its chemical action for 40 to 50 seconds. If the lines appear at once in blue, and the ground of the paper is also tinted blue, the exposure is insufficient and must be continued. These tests are continued after intervals of a few seconds with fresh slips of test paper, until a point is reached when the paper remains yellow and quite free from blue spots, but the lines appear sharply reproduced in blue, which indicates that the exposure is exactly sufficient. If, however, the ground of the paper remains yellow, and the lines are broken and faint, the print has been over-exposed and should be rejected.

The development of the prints must be performed in a yellow or very dim light. The developing solution consists of a solution of ferrocyanide of potassium (yellow prussiate of potash) at 20 per cent., or about saturation, and is placed in a shallow tray. The prints are floated face downwards on the prussiate bath, care being taken not to get any of the solution on the back and to exclude air-bubbles. After floating for half a minute, the print is lifted by raising one end with care, and the action of the prussiate is allowed to continue, but only so long as the yellow ground remains free of blue spots. The longer the print can be kept with the film of prussiate on, the stronger and darker will the lines come out. As soon as blue spots begin to appear on the yellow background, the print must at once be immersed face downwards in a second tray containing clean water, which checks the further action of the prussiate solution. After a thorough washing in water, the print is placed in a third bath of weak sulphuric or hydrochloric acid; the former at 3 per cent., the latter at 8 to 10 per cent. With a soft brush the surface of the print is now dabbed all over until the gum is entirely removed. The print is again well washed in water, either in the second tray, which should meanwhile have been washed out, or better in a fourth tray specially kept for the purpose. The lines of the tracing will then be found to stand out blue on a clear white ground.

The following causes of failure should be noted. A blue discolouration of the prints arises from under-exposure to the light, or from the print having been kept too long exposed to the action of the prussiate bath. If the lines are broken and pale, while the ground remains white, it may be due to over-exposure, or to the lines of the tracing not being sufficiently opaque to stop the passage of light through them. If, when the print is put in the acid bath, the lines turn a dark blue which washes off when being brushed, this arises from insufficient development in the prussiate bath; if the ground is also blue spotted, it is from under-exposure.

If in spite of all precautions stains or spots of blue appear on the ground of the print, they may be easily removed, or alterations made in the drawing, by means of a solution of oxalate of potash, made by dissolving one part of the neutral salt in four parts of water. A solution called "*Blue Solving*" is sold ready prepared for this purpose. The liquid is applied lightly with a camel's-hair brush to the stains or lines to be erased and dried off with blotting-paper. When dry, the parts will appear white. This solution should only be applied to the prints when dry.

Prints produced by this process are quite permanent and unchangeable by light or damp.

PHOTO-COLLOTYPE SECTION.—The number of plates prepared and printed was 30 and of prints 4,929. These chiefly consisted of plates to illustrate the Bengal Asiatic Society's Journal and include reproductions of photographs taken in the office, of an ancient brass vase and of a bronze figure of Hercules found in the Quetta Miri, and of various gold and silver coins, ancient copper-plate inscriptions, &c.

Owing to the substantial advances in the photo-etching process of heliogravure, and the ease and simplicity with which photo-etched plates are now obtained, as well as the greater certainty and regularity in printing from them, I have not thought it worth while to continue working the collotype process, as there is not much suitable work coming in. The only way in which collotype could now be worked with advantage would be with steam machinery, by which large numbers of prints could be produced rapidly and more even in quality than they can be when printed by hand. When we have these advantages in the new buildings, it may be possible to again utilise this method of printing half-tone subjects.

HELIOGRAVURE SECTION.—The work done in this section shows a very large increase, and there has been steady employment for the section all the year through, so that attention has been more devoted to perfecting the photo-etching process in small details than to experimental work. Eighty-two plates have been prepared by the photo-etching and photo-electrotype methods, from which 10,762 prints have been struck off from our own two presses, besides 7,778 in the Copper-plate-printing Section of the Engraving Office.

PHOTO-ELECTROTYPE PROCESS.—This method worked with fair success during the year, and no change was made in the working details. Its principal use has been for line-work; but now that we have been able to produce almost superior results in this style by the simpler and more rapid method of photo-etching, photo-electrotype has fallen into disuse.

Fourteen plates in continuation of the Technical Art series have been done for the Revenue and Agricultural Department by this method; also sheets V and VI of the Andaman Survey, and two architectural plates for Colonel Jacob, Jeypore. It has also been found useful for making transfer plates of line subjects which were too fine for ordinary photo-zincography. A thin plate is deposited from which transfers are pulled for transfer to stone or zinc.

PHOTO-ETCHING PROCESS.—This process has been worked very successfully throughout the year by Mr. Turner. The method of working remains much the same, but has been improved in details, and now that fine line-work can be successfully reproduced in this way the process will be found to be more generally useful than photo-electrotype. Reversed negatives are not required, and, unless the plates are of permanent value and have to be kept, they cost less for material, as the copper-plates can be used many times over. The etched plates require very little working up, and a means has now been devised by which transfers from type can be put on the transparency and etched in together with the subject, by which nearly all engraver's work on the plates is saved. The majority of the heliogravure plates done during the year have been done by this process, including 13 for Dr. Burgess' report on Jaunpur, of which 9 were half-tone plates from the original negatives taken from nature. Fifteen small plates were also done for the Quartermaster General's Department from photographs taken by Dr. Giles, who accompanied the Gilgit Mission.

As the process is now in full working order, and several modifications have been made since it was first described in the Annual Report for 1883-84, it seems desirable to give a complete description of it with all the latest improvements.

Original Negatives.—These should be unreversed, of good quality, clear, bright, and not too dense. For half-tone work a good silver-printing negative will generally give good results. For line-work the negative need not be so dense as for photo-lithography, but should be clear and bright, and show the finest lines well. As the process possesses more power of bringing out faint lines than does photo-zincography, it is better as a rule to intensify with pyrogallic acid and silver, rather than with the usual intensifier used for negatives of maps. In order to secure clean borders on the copper-plate, the subject must be masked out on the negative with thin opaque paper or black varnish.

The Transparency.—As a *negative* image is required on the copper, a *reversed* transparency must be prepared from the negative, and the simplest way of doing this is by means of the autotype special transparency tissue developed upon a glass plate by the ordinary autotype pigment-printing process. When subjects have to be enlarged or reduced the transparencies are best obtained in the camera on gelatine dry plates, but should not be too dense; care must also be taken that they are properly reversed, so as to produce a negative image on the copper-plate. Looked at from the film-side, the image should be reversed just as it is on the negative.

Transparencies can also be obtained with the ordinary autotype standard brown or other tissues, and this method is particularly suitable for dense negatives, which would take a long time to print and give heavy shadows. Formerly such transparencies were intensified with permanganate of potash, but this is not now found necessary. The transparencies obtained with the special transparency tissue do not require intensifying, even for line subjects. The exposure under the negative varies, but from 20 to 30 minutes is usually sufficient for half-tone subjects, and for line subjects about 2 minutes in the sun. The transparency should be clear and bright in the lights and not too dense in the shadows.

Held at a short distance from a sheet of white paper, the effect should be very much as desired in the finished print, because the etched images reproduce very closely the characteristics of the transparency. Before being printed from, a mask of the size the finished picture is desired to be should be cut out of thin, semi-transparent paper and applied on the back of the transparency, so as to provide a 'safe edge,' to prevent the picture washing up on development.

The Copper-plates.—These should be of the usual thickness as prepared for the use of engravers and of the best copper, free from holes, flaws or surface markings, which will assuredly be brought out in the subsequent operations of steel-facing and spoil the effect of the prints. They must be finely polished by rubbing with oil and fine tripoli or flour-emery, finishing up with powdered chalk applied with a felt pad. They then have to receive a fine resinous grain, in order to hold the gelatine film during the after-process of etching and also to break up the etched parts of the surface of the copper irregularly, so as to give them the necessary holding power to retain the ink during the printing. We have found that the best substance for this purpose is very finely powdered bitumen, though powdered rosin, or a mixture of the two, may also be used. The powdered bitumen is placed in a large box, which is best mounted on pivots, so that it can be turned over to allow the dust to fall from one side to the other; or, if the box is not so mounted, the powder can be blown up with a bellows or stirred up in any way so as to produce a cloud of fine dust inside the box. As soon as the coarser particles have subsided, the plate is placed near the bottom of the box and left for 5 or 10 minutes till a sufficient quantity of the dust has been deposited upon it. A more even grain is obtained for fine work by allowing the dust to settle longer (for two minutes) and repeating the operation two or three times, so as to have a large quantity of very fine dust. For half-tone subjects more grain is required than for line, and dark heavy subjects require a stronger grain than light and fine ones. Some experience is necessary to know the proper amount. The loose deposit of bitumen has next to be fixed to the plate. Formerly this was done by exposing the plates for a few seconds to the fumes of benzole or oil of lavender, but Mr. Turner has found it better to do it by heat, the plate being moved about for a short time over a dish containing a little flaming spirit of wine. A heater warmed by gas would, however, be better. It is an advantage to allow the plates to cool spontaneously after this operation. The plates are then ready to receive the negative transfer print from the transparency.

The Negative Pigment Print.—The tissue that has been found to answer best for producing the negative image in gelatine on the copper-plate is the Autotype Company's Standard Brown, No. 100. The Company have lately introduced a new special tissue for this purpose, of which they kindly sent us a specimen for trial. It was, however, not found to answer better than the cheaper Standard Brown. It contains very little gelatine, and the pigment used in its preparation is very opaque, requiring fully three times the exposure of the Standard Brown tissue, and it is more difficult to watch the action of the perchloride of iron during the progress of the etching. The ordinary tissue is sensitised by immersion for 1 to 4 minutes, according to the season of the year, in a solution of—

Bichromate of potash	30 parts.
Spirit of wine	150 „
Ammonia	4 „
Water	700 „

It is squeezed down upon a glass plate prepared with French chalk, fanned for about half an hour, placed in a box containing chloride of calcium, and left to dry. It has been found advantageous in the cold weather to leave the tissue for a few days in the chloride of calcium box before use. For the new special tissue the strength of the above bath was increased by reducing the water to 600 parts and omitting the ammonia.

The sensitised tissue is cut carefully square to the size required and laid in its place over the masked transparency in an ordinary printing frame and exposed to the sun or diffused light for a sufficient time to produce a thin, bright image when developed on the copper-plate.

Development.—The copper-plate bearing the dust grain is placed in a dish of cold water—in hot weather ice must be used to lower the temperature to at least 60°— and the exposed tissue is immersed in the water, quickly arranged in its place on the copper-plate and withdrawn with the latter as soon as possible and squeezed down upon it. In the cold weather the tissue should be allowed to soak in the water for about two minutes, and more time can be taken in placing it in position on the plate. The plate with the tissue is left for a time and then developed in the usual way with warm water. It is better to slightly over-expose and reduce the image, if necessary, by the addition of a small quantity of bicarbonate of soda in the warm water. It is very important that the image should be thoroughly developed and free of any soluble gelatine. The image being negative, *i.e.*, the lights of the picture being represented by varying thicknesses of gelatine and the shadows by more or less clear copper, some care is required in development, and this should be conducted slowly with water at a moderate temperature.

After development, the plate is flowed with a 5 per cent. solution of alum and dried off with spirit of wine. This clears up the shadows and gives a sharper and crisper image than is obtainable by drying spontaneously. It is well to begin with a weak spirit, containing about equal parts of spirit and water, flowing it over the plate from one corner so as to drive before it the water in the film together with the insoluble scum which the

spirit forms with any loose soluble gelatine remaining on the surface, and which must be removed with care to avoid markings on the surface. After treatment with stronger spirit till all moisture is removed, the plate may be set aside to dry, but in hot weather it should be finally flooded with a solution of 1 part of glycerine in 20 parts of spirit of wine, in order to prevent the splitting off of the film on drying.

The plate is now ready for etching. The borders all round the picture, as well as the back of the plate, are painted with a varnish containing 20 per cent. of bitumen dissolved in benzole and left to dry thoroughly.

For etching, solutions of perchloride of iron are used in 5 different strengths, as shown in the table below:—

No.	Strength on Baumé's scale.	Sp. Gr. at 63° 5 Fah.	Approximate percentage of $Fe^2 Cl^6$.
I	45°	1,444	47
II	40°	1,375	41
III	38°	1,349	38
IV	35°	1,313	35
V	27°	1,225	2

A stronger solution at 48° Baumé has also been tried, but has no penetrating power through even the thinnest film of gelatine.

The solutions are laid out in a series of flat dishes, into which the plate to be etched is immersed in order, beginning with the strongest (No. I). For line work, as a rule, only Nos. I and II are used, the plate being left in No. I for about 2 minutes and then removed to No. II for another 3 minutes.

For half-tone work, the plate is immersed in No. I and not left more than 1 minute after the copper is first attacked; it is then transferred to No. II and allowed to remain for 3 or 4 minutes; then it is passed into No. III and remains for 2 minutes; to No. IV for 1 minute, and, finally, to No. V where it remains for about a minute, till the highest lights are just about to be attacked. The use of the different strengths of perchloride and the time the plates should be exposed to them are matters which depend on the nature of the film, the temperature, and the hygrometric state of the weather at the time, and must be learnt by practice. A very good guide for the time the plate should remain in each solution is till the action of the perchloride appears to stop: it is then time to transfer it to a weaker solution, or a distinct line will be shown, and result in a hard, black and white picture. With the Autotype standard brown tissue there is no difficulty in following the progress of the etching in its different stages. The whole operation is usually completed in from 5 to 10 minutes and should be stopped as soon as it is seen that the high lights are sufficiently bitten. In dry, cold weather it has been found that the gelatine has less resisting power than it has in the warmer months, when there is more moisture in the air. Stronger solutions are therefore required as the weather becomes drier and colder.

As soon as the plate is considered sufficiently bitten, it is washed under the tap with a strong current of water, so as to drive out the perchloride of iron as quickly as possible. The gelatine film is then gently removed by rubbing with a muslin or cotton rag. The plate having been dried, the asphaltum varnish is carefully washed off the face and back with benzine. The face of the plate is rubbed over with a little whiting and ammonia, dried and polished off with a little spirit of wine. The plate should now show a fine, smooth polish on the highest lights, with a gradually increasing depth of biting through the lights to the shadows, with a fine, clear grain throughout.

Obtained as above described, the plates now require no re-biting and very little touching up beyond oil-rubbing and cleaning.

The lettering for half-tone plates is usually done by hand, but recently we have adopted a method of lettering the transparencies by printing from type on slips of thin collodionised gelatine, which are cut and fastened on their proper places in the transparency. In order to make the printing more opaque it is dusted over with red bronze powder which adheres to the freshly printed letters and gives them great opacity. Facsimile names and writing or printing on thin paper can also be inserted by coating the plate with sensitive asphaltum solution and exposing it to light under the writing, &c., then developing with turpentine or benzine and etching with perchloride of iron. Flat or shaded tints can also be inserted on the plates by applying and fixing the dust-grain, then stopping out on the plate all but the parts required to be tinted, and etching with solution of perchloride of iron at 20° Baumé. This satisfactorily takes the place of machine-ruling on architectural drawings and is much less trouble. In skilled hands a variety of effects could be produced by the combination of photo. and hand-etching.

After lettering and touching up, the plates are carefully steel-faced and are ready for printing. They require very careful inking and wiping off and a good pressure in printing to avoid streaks or woolliness. The native printers soon learn the work, and with due care the proportion of spoiled prints is small—much more so than with collotype.

ASPHALT PROCESS.—With a view to obtaining accurate impressions on zinc plates for purposes of colour printing, Mr. Turner tried several experiments with the asphalt methods, which were quite successful, and either this process, or the one already described as worked out by Mr. Harrold in the Photo-transfer Section, would be exceedingly useful for all

colour work where accurate register is necessary and for the finer classes of line-work. The only objection is that reversed negatives are required.

The sensitising solution of asphalt is prepared by taking 4 oz. of the best Syrian asphaltum, grinding it and then washing it well with ether in a bottle, pouring off the soluble portion and adding fresh ether four times with an interval of about an hour between each change. This leaves about 50 per cent. of asphaltum insoluble in ether; this is dried and can be kept in stock. The object of washing with ether is to remove the more insensitive components of the asphaltum. A 2 to 3 per cent. solution of this prepared asphaltum is made in benzole. It should be allowed to stand for an hour or two and then carefully filtered. This solution appears to keep any length of time. The solution in turpentine throws down an insoluble deposit after a short time, but this may be prevented by the addition of chloroform or thymol.

A little practice is required to coat large plates successfully with the benzole solution, owing to its quick evaporation. Mr. Turner finds it best to lay the thin zinc plate on a sheet of glass of the same size and pour the asphaltum solution over the plate in the same way as collodion, running it off very quickly at the right-hand lower corner. A considerable quantity of the solution should be left on the plate, sufficient to keep it liquid all over. The solution is then flowed rapidly back to the left-hand top corner and put to dry on a stand on which the centre of the plate only is supported. The two ends hanging over form a natural curve to the plate that gives a very even coating. This method of drying has been adopted from a suggestion of Prof. Husnik, of Prag, and is very efficient, no difficulty having been experienced in coating plates up to 32 × 24. The plate will be dry and ready to print in a couple of minutes. The asphalt coating as thus prepared is very sensitive, and in the sun an exposure of 10 minutes is sufficient for a good, clear line, negative; in bright diffused light, 20 minutes to half an hour will suffice. If printed in the sun great care must be taken that the plates are quite cooled down before beginning to develop. To make sure of this it is well to put the plates into cold water till cool and then thoroughly dry them before putting them into the developing bath of turpentine. It was found that a very slight degree of heat in the plate affected the development considerably, causing the asphalt to dissolve away and appear under-exposed.

The development is performed by placing the plates in a dish with sufficient turpentine to cover them well. The dish should be gently rocked till the image appears, and the plate is allowed to remain till all the soluble asphalt is dissolved. If well exposed, plenty of time can be taken with the development without danger of injuring the fine lines. When sufficiently developed the plate is taken out and immediately washed in a strong jet of water, commencing at the near edge of the plate and following the turpentine as it is repelled by the water off the opposite side. The plates should be thoroughly washed in plenty of water for about 5 to 10 minutes, and are then ready for etching and inking up in the same way as an ordinary transfer. After etching, as usual, with the ordinary nutgall and gum solution, the asphalt image must be entirely cleaned off with benzole. Where any part of it remains it will refuse to take the ink.

EXPERIMENTAL WORK.—The principal experimental work done during the year, besides the direct printing on thin zinc plates by the collo-chromate and asphalt methods already described, has been with the view of obtaining reversed positives or transparencies direct in the camera, as well as by conversion of negatives taken in the ordinary way. If suitable transparencies could be obtained in some such simple manner, it would be a great saving of time and trouble and avoid the difficulties inseparable from the preparation of transparencies by the carbon or pigment printing process, more especially in hot weather.

The experiments have been for the most part made by Mr. J. T. Meade, who worked up and tried all the methods hitherto published, including Poitevin's, Sabatier's, Foxlee's, with wet collodion, and Brooke's and Carrol's with gelatine dry plates. The only method that seemed likely to be of really practical use is that formerly used in the French Depôt des Fortifications, of which a description was published in 1881 by M. V. Roux, and in the *Bulletin de la Société Francaise de Photographie*, Vol. XXVII, p. 130, by Captain Biny of the French Engineers.

The following is a sketch of the method as found most suitable for working here. It is necessary first of all to give the glass plates a good coating of albumen, in order to hold the films down while in the acid baths. The plate is then coated with bromo-iodised collodion and sensitised in the usual way. The exposure in the camera is rather shorter than for ordinary work. It is developed with iron, but not too much, and not intensified with silver, washed thoroughly, and then intensified in the usual way with acid, pyrogallic acid and silver solutions made as follows:—

(1)	Water	1,000
	Pyrogallic acid	5
	Citric acid	25
	Alcohol	10
(2)	Distilled water	500
	Silver nitrate	10
	Acetic acid	40

When sufficiently intensified the plate is well washed, and then placed, film upwards, on a black board and exposed to diffused daylight for a time varying from 10 seconds to a minute or more, according to the brightness of the light, until the unexposed yellowish parts of the negative gradually change to a purplish grey (a few trials will show exactly the

tint required). Some chloride of zinc may be added to the collodion, so as to form a small quantity of chloride of silver in the film, which will change colour when exposed to light and give a better index to the proper exposure.

The plate is then taken in to the dark room, washed, and immersed quickly with one movement in a bath composed of—

Bichromate of potash	30
Pure nitric acid	300
Water	700

This operation may be performed in a weak diffused light. The plate should be carefully watched in the bath, and when the negative image is seen to have entirely disappeared, or dissolved away by the nitric acid, which takes place in a few seconds in a fresh bath, it should be removed immediately and quickly washed with a strong jet of water to remove all traces of the nitric acid before proceeding with the development of the positive image.

The plate should now show a positive image in a pale straw colour, while the parts which have been dissolved will appear of a brick-red colour, owing to the formation of chromate of silver.

Before proceeding further it is better to dissolve off the chromate of silver by means of the following solution :—

Bichromate of potash (saturated solution)	30
Alcohol	30
Pure nitric acid	30
Water	400

The solution of bichromate of potash is placed in a glass beaker and the alcohol added to it, which causes a precipitate. The nitric acid is then added by degrees, stirring all the while. The precipitate re-dissolves and an odour of apples is evolved. The water is then added. This solution should not be allowed to remain on the plate longer than is sufficient to clear off all the red chromate; and, if too strong, it may be reduced with water. The plate is then thoroughly well washed and re-developed with pyrogallic acid and silver. The solution of pyrogallic acid is composed of—

Pyrogallic acid	25
Citric acid	25
Alcohol	50
Water	1,000

The solution is first poured over the plate, then poured back into the developing cup. A small quantity of a weak solution of nitrate of silver at 1 per cent., acidified with acetic acid, is added and the mixture poured again on the plate, when the positive image gradually begins to gain strength. The additions of silver solution should be carefully made and the re-development not carried too far. When finished, the plate is washed and fixed in the usual way with hyposulphite of soda or cyanide of potassium, and thoroughly washed. Should the ground appear slightly veiled, it can be cleared by the application of a weak solution of iodine and iodide of potassium in water, followed by treatment with weak cyanide or hypo-solution as in the ordinary photo-zinco. process. When clear, the plate can be further intensified, if necessary, with bichloride of mercury, bromide of copper, &c., in the usual way.

For half-tone subjects the method is the same, but the nitric acid bath should be much weaker—the formula being then—

Bichromate of potash	12 grammes.
Pure nitric acid	75 c.c.
Water	700 „

Less silver should be used in re-developing the positive image. The amount of exposure to light requires to be very accurately judged, and upon it and care in re-developing the success of the result depends. Captain Biny recommends a re-development with iron and very weak silver solution, pyrogallic acid being apt to give dense, hard results.

The methods above described appear perfectly practical, and will be very useful for obtaining reversed transparencies for maps, &c., for use in the photo-etching process. A small specimen map produced in this manner gave a very sharp, clear result, and in this respect superior to the usual run of work produced from the carbon transparencies, on which there is often a considerable thickness of gelatine which prevents close contact in the printing frame.

The method might also be found of advantage in reproducing maps in two or more colours from a single original drawn in black. It is much easier to produce the requisite separate clichés for each colour by scraping the lines off a transparency than it is to paint them out of a negative.

ORTHO-CHROMATIC PHOTOGRAPHY.—We are so seldom asked to reproduce paintings or coloured drawings that the new ortho-chromatic methods of doing this class of work do not come much within the working scope of the office, and consequently they have not received much further attention during the year. When required, the method described in last year's report of staining gelatine dry plates (by preference Wratten and Wainwright's "ordinary") in a bath of erythrosin-silver and ammonia is followed, and when it is inconvenient to use the yellow beam reflected from a mirror covered with a transparent yellow screen, very good results can be obtained by placing a yellow screen in front of the

lens, made with a piece of *parallel plane* glass coated on one side with a clear varnish composed of a mixture of—

Turmeric varnish	. . . . .	2 parts.
Annatto do.	. . . . .	1 part.
Kamala do.	. . . . .	1 „

This varnish has the advantage of giving a more structureless film than collodion or gelatine. The different varnishes are made by adding the dyes (powdered turmeric, annatto seeds and kamala powder) to ordinary benzole crystal varnish, and may be used in varying proportions according to the tint required, the annatto giving a red tone, the turmeric a greenish yellow, and the kamala a neutral yellow between the two.

Good results have also been obtained by placing a glass plate coated with the above yellow varnish or with coloured collodion or gelatine in front of the picture to be copied.

I commenced a series of experiments on various eosin dyes obtained from the Basle Society of Chemical Industry and other sources, to ascertain the most suitable for use with collodion and with gelatine, but had to give them up on account of other work. The most promising results with collodion were obtained with cyanosin (the potassium salt of tetrabromtetrachlorfluoresceine ethylether); phloxin (the potassium salt of tetrabrom dichlorfluoresceine); erythrosin B (Basle) (the sodium salt of tetrabromtetrachlorfluoresceine), and yellow-shade eosins (J. L. of Basle —the sodium salt of tetrabromfluoresceine —and Brooke, Simpson and Spiller's).

For gelatine the blue-shade eosins (B. A. of Basle —the potassium salt of tetraiodfluoresceine, which is similar to ordinary erythrosin) were found to give more yellow-sensitiveness than the yellow-shade. The addition of ammonia, in the proportion of about 1 per cent. of the staining bath, increases the yellow sensitiveness, acetic acid destroys it. Washing off the excess of the dye after staining was also tried, but its efficacy in increasing sensitiveness seems doubtful. Annatto added to erythrosin was not found an improvement, but the addition of uranin greatly increased the sensitiveness to spectrum-green.

Using the stained gelatine plates while wet with the dyes was also tried, but was not found an advantage, the sensitiveness being less and the swollen state of the gelatine film spoiling the sharpness of the image.

I hope to be able soon to resume these experiments.

In connection with this subject it may be mentioned that in copying some monochrome shaded drawings done in rather a blue shade of neutral tint or Payne's grey, it was found a great advantage to place a glass plate coated with collodion coloured with eosin over the drawing, so as to lower the blue tone and enable the different shades to be reproduced in proper gradation and strength.

PERSONAL WORK.—My time during the year has been largely taken up by work connected with the fittings and arrangements for the new buildings, and I have consequently had but little time for experimental or other photographic work. I have, however, given some attention to the new printing-out platinum process, but find it very slow and the results not so good as with the older methods. I have also tried the new hydroquinone developer for dry plates and find it useful for instantaneous work. With some makes of plates, among them Swan's, it stains the gelatine films yellow when used in combination with sulphite of soda. It seems likely to be very useful for developing prints on bromide paper, and gives them a pleasanter colour than ferrous oxalate. I have also made several experiments on the absorption spectra of various coal-tar dyes with reference to their power of increasing the sensitiveness of gelatine dry plates for the less refrangible parts of the spectrum and their further, possible use in orthochromatic photography. Further work is necessary before the results can be collated and published. I have also prepared, with Mr. Pope's assistance, a set of tables of metrical weights and measures for use in the office and general purposes, to be printed as an appendix to the Code of Rules for the Photographic and Lithographic Offices, which is now nearly completed and ready for printing. It has been delayed on account of necessary changes and from pressure of other work.

Mr. T. A. Pope, Assistant Superintendent, has given me a good deal of assistance in carrying on the work of the office. He has drawn up an account of the various simple printing processes and has worked many of them out. It is proposed to print this hereafter for departmental and general use.

NEW BUILDING.—It is very gratifying to be able to report that the new buildings for the accommodation of the Photographic and Lithographic Offices have been sanctioned by Government. The first sod was turned by Mrs. Thuillier on the 2nd February 1888, and at the end of the year under report the buildings were in an advanced state of progress. It is hoped that they will be complete and ready for occupation about July next. As stated in my report of the Lithographic Office, it is proposed to introduce steam machinery for zinc and lithographic printing, and this will be a great advantage in expediting the outturn of our printing work and improving its quality. The fittings and arrangements of the new buildings have been very carefully considered, and will, I trust, be found satisfactory.

PHOTOGRAPHIC OFFICE, CALCUTTA.

PHOTOGRAPHIC

Statement of Departmental Work done

Specification of Plate or Print.	Scale of Map.		Sheets or subjects.	Negatives.		Photozincographic Printing.				
	Original.	Reproduced.		Direct negatives.	Reversed negatives and transparencies.	Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Pulls.	Copies.
General Maps.	In. M.	In. M.								
[Burma] Province and Regions adjacent, by Captain Yule	...	...	1	4	...	4	1	1	100	100
[Railway] Map of India	...	...	...	...	...	...	...	13	1,182	1,182
[Secretary] of State's Map of India	1=32	1=48 1=64 1=96	7	16	...	16	6	10	700	700
Total	...	...	8	20	...	20	7	24	1,982	1,982
Provincial Maps.										
[Pro]vince of Bengal (electro-matrix)	...	...	1	...	...	...	...	...	...	...
[Pre]liminary Map of Upper Burma	1=8	1=8	2	8	...	8	3	3	1,509	1,509
Do. do.	...	1=16	...	...	...	36	1	4	585	585c
Total	...	...	3	8	...	11	4	7	2,094	2,094
Divisional Maps.										
Bhagalpur	1=8	Half	2	4	...	4	1	...	...	...
Burdwan	1=4	Half	2	2	...	2	1	...	...	...
Chittagong	1=8	1=24	3	2	...	2	1	1	125	125
Patna	1=4	Half	8	8	...	8	2	...	...	...
Pegu	[illegible]	...	...	...	...	...	...	4	80	80
Total	...	...	15	16	...	16	5	5	205	205
District Maps.										
Bengal—										
Hill Tipperah and Manbhoom	...	...	...	...	...	...	...	1	100	200
Central Provinces—										
Chanda	1=16	...	1	1	...	1	1	1	300	300
Jubbulpore, Saugor and Wardha	...	...	...	...	...	...	...	1	300	900
Punjab—										
Jullundur and Ludhiana	1=4	...	2	8	...	8	2	...	...	...
Total	...	...	3	9	...	9	3	3	700	1,400
Plans of Cities and Cantonments.										
Mandalay City and Plan of ruins of Pagan—										
Sheets Nos. 1, 2, 3, and 4	6=1	6=1	4	16	...	16	4	4	400	400
Sabathu Cantonments	24=1	24=1	3	12	...	12	3	...	...	...
Simla and Jutogh (Guide Map)	8=1	6=1	1	4	...	4	1	...	...	...
Simla Guide Map (New Edition)—										
Sheets Nos. 1 to 17, 19 and 20, Title Sheet and Index	24=1	¼	39	38	...	36	2	...	...	...
Total	...	...	47	70	...	68	10	4	400	400
Atlas of India.										
Quarter Sheet No. 9 S. E.	...	...	1	...	...	...	...	...	...	...
Standard Maps.										
Afghanistan, Northern—										
2 Maps	1=1	1=1	2	8	...	8	2	2	100	100
Andaman Islands—										
Sheets Nos. 3 and 11	1=2	1=2	1	4	...	4	1	1	150	150
Bengal—										
District 24-Pergunnahs, Section 3	1=1	1=1	1	4	...	4	1	1	50	50
,, Cuttack, Sheet No. 196	2=1	Half	4	4	...	4	1	...	...	...
Bombay—										
Sheets Nos. 86, 103, 119, 182, 214, 215, 216 and part of Palanpur and Baroda State, Sheet No. 87	2=1	1=1	32	32	...	32	8	8	1,200	1,200
Sheets Nos. 52, 53, 70, 71, 72, 73, 88, 89	...	...	...	...	...	...	...	27	4,050	4,050
,, ,, 134, 168, 172, 173, 191, 199										
,, ,, 204, 214, N.E., N.W., S.E., and S.W.										
,, ,, 215, N.E., N.W., S.E., S.W., 227										
,, ,, 260, 275, and 276										
Sheet No. 187	4=1	2=1	4	4	...	4	1	1	150	150
District Belgaum—										
Sheet No. 243	2=1	1=1	4	4	...	4	1	...	...	...
Khandesh and Bombay Native States—										
Sheet No. 16	1=1	1=1	1	4	...	4	1	...	...	...

OFFICE, CALCUTTA.

during the year 1887-88.

Silver and other Printing.			Heliogravure and Electrotyping.					Photocollotype.		Value.	Remarks.
Silver prints.	Blue prints.	Miscellaneous prints.	Plates photo-electro-typed.	Plates photo-etched.	Prints.	Photo blocks.	Electro-types.	Plates.	Prints.		
										₹ a. p.	
...	...	...	...	...	...	...	...	...	...	80 14 0	
...	...	...	...	...	...	...	...	...	...	327 15 0	Reprint.
...	...	...	...	...	...	...	...	...	...	482 15 3	4 Plates reprinted.
...	...	...	...	...	...	...	...	...	...	891 12 3	
...	...	...	...	...	...	...	1	...	...	37 12 9	For duplicate.
...	...	...	...	...	...	...	...	...	...	403 13 3	
...	...	...	...	...	...	...	...	...	...	151 9 9	*b* Taken from old Negatives.
											c 450 copies re-printed.
...	...	...	...	...	...	...	...	...	...	593 3 9	
...	...	...	...	...	...	...	...	...	...	51 9 6	
...	...	...	...	...	...	...	...	...	...	30 0 0	
...	...	...	...	...	...	...	...	...	...	34 7 9	
...	...	...	...	...	...	...	...	...	...	104 6 3	
...	...	...	...	...	...	...	...	...	...	15 3 3	Reprint.
...	...	...	...	...	...	...	...	...	...	235 10 9	
...	...	...	...	...	...	...	...	...	...	9 6 0	
...	...	...	...	...	...	...	...	...	...	33 5 3	
...	...	...	...	...	...	...	...	...	...	41 12 6	
...	...	...	...	...	...	...	...	...	...	97 3 3	
...	...	...	...	...	...	...	...	...	...	181 11 0	
...	...	...	...	...	...	...	...	...	...	324 12 9	
...	...	...	...	...	...	...	...	...	...	170 6 3	
...	...	...	...	...	...	...	...	...	...	54 9 6	
...	...	...	...	...	...	...	...	...	...	324 0 0	
...	...	...	...	...	...	...	...	...	...	873 12 6	
...	...	...	1	...	...	...	...	...	...	145 12 9	
...	...	...	...	...	...	...	...	...	...	131 1 6	
...	...	...	...	...	...	...	...	...	...	93 11 9	
...	...	...	...	...	...	...	...	...	...	74 11 0	
...	...	...	...	...	...	...	...	...	...	52 12 9	
...	...	...	...	...	...	...	...	...	...	739 1 0	
...	...	...	...	...	...	...	...	...	...	1,122 0 6	
...	...	...	...	...	...	...	...	...	...	90 11 9	
...	...	...	...	...	...	...	...	...	...	52 12 9	
...	...	...	...	...	...	...	...	...	...	52 12 9	

PHOTOGRAPHIC

Statement of Departmental Work done

Specification of Plate or Print.	Scale of Map.		Sheets or subjects.	Negatives.		Photozincographic Printing.				
	Original.	Reproduced.		Direct negatives.	Reversed negatives and transparencies.	Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Pulls.	Copies.
Standard Maps—contd.	In. M.	In. M.								
Burma (Lower)—										
Districts Hanthawaddy, Henzada and Tharrawaddy— Sheet No. 231	2=1	1=1	8	8	...	8	2	2	300	300
Districts Hanthawaddy and Henzada— Sheet No. 232										
District Bassein— Sheets Nos. 143 and 188	2=1	1=1	12	12	...	12	3	...	...	...
District Hanthawaddy— Sheet No. 233										
District Bassein— Sheet No. 141										
District Henzada— Sheets Nos. 183 and 186										
Districts Prome and Tharrawaddy— Sheet No. 227 $\frac{\text{N.E.}}{1,3}$, $\frac{\text{N.W.}}{4}$, $\frac{\text{S.E.}}{1,2}$ and $\frac{\text{S.W.}}{4}$	4=1	4=1	...	...	...	...	...	14	1,800	1800
District Shwegyin— Sheet No. 25 N.E., N.W., S.E., and S.W.										
" " 277 $\frac{\text{N.W.}}{1}$										
Sheets Nos. 3 $\frac{\text{N.W.}}{1}$ and 227 $\frac{\text{N.W.}}{3}$	4=1	4=1	2	6	...	6	2	...	...	...
Central India and Rajputana—										
Sheets Nos. 253 and 402	...	1=1	...	...	...	...	...	1	225	225
" " 385, 386, 388, 403, 404 and 405	1=1	1=1	6	24	...	24	6	6	900	900
" " 387, 415, 416 and 417	1=1	1=1	4	16	...	16	4	...	...	...
Central Provinces—										
Sheet No. 12	1=1	1=1	1	4	...	4	1	...	...	...
Hooghly River—										
Sheets Nos. 4, 6, 7, 9 and 10	...	...	...	...	...	...	...	5	750	750
Mysore—										
Sheet No. 63	1=1	1=1	1	4	...	4	1	1	100	100
North-West Provinces—										
Districts Ballia and Ghazipur— Sheet No. 210										
Districts Benares and Ghazipur Sheets Nos. 195 and 196		1=1	16	16	...	16	4	4	600	600
District Mirzapur— Sheet No. 183										
Districts Aligarh, Etah and Muttra— Sheet No. 37										
District Ballia— Sheets Nos. 218, 220 and 221										
Districts Ballia and Ghazipur— Sheet No. 219	2=1	1=1	...	...	...	...	...	6	900	900
Districts Benares and Ghazipur— Sheet No. 211										
Districts Aligarh and Muttra— Sheet No. 23 (coarse set)										
Districts Ballia and Gorakhpur— Sheet No. 217										
Districts Benares and Jaunpur— Sheet No. 180										
Districts Benares, Jaunpur and Mirzapur— Sheet No. 181	2=1	1=1	29	29	...	29	7	...	...	...
District Gorakhpur— Sheet No. 216										
District Mirzapur— Sheets Nos. 169 and 171										
District Aligarh— Sheet No. 23 N. E. and S. E. (Fine set)	2=1	2=1	2	8	...	8	2	...	...	...
N. W. Provinces and Oudh—										
Sheet No. 56A	...	1=1	...	...	...	...	...	1	150	150
Districts Basti, Fyzabad and Gonda— Sheet No. 162	2=1	1=1	4	4	...	4	1	...	...	...
N. E. Trans-frontier—										
3 Maps	1=4	1=4	4	16	...	20	5	2	300	300
N. W. Trans-frontier—										
18 Maps	1=4	1=4	21	74	...	72	19	20	2,258	2,258
9 Maps	1=2	1=2	13	52	...	52	13	8	2,400	2,400
16 Maps	2=1	2=1	15	45	...	45	15	19*	2,235	2,235

OFFICE, CALCUTTA.

during the year 1887-88—continued.

Silver and other Printing.			Heliogravure and Electrotyping.					Photocollotype.		Value.	Remarks.
Silver prints.	Blue prints.	Miscellaneous prints.	Plates photo-electro-typed.	Plates photo-etched.	Prints.	Photo blocks.	Electro-types.	Plates.	Prints.		
										R a. p.	
...	...	...	...	...	...	...	...	...	...	191 1 0	
...	...	...	...	...	...	...	...	...	...	158 6 3	
...	...	...	...	...	...	...	...	...	...	512 4 0	
...	...	...	...	...	...	...	...	...	...	96 9 6	
...	...	...	...	...	...	...	...	...	...	68 2 6	
...	...	...	...	...	...	...	...	...	...	553 6 6	
...	...	...	...	...	...	...	...	...	...	211 3 0	
...	...	...	...	...	...	...	...	...	...	52 12 9	
...	...	...	...	...	...	...	...	...	...	188 14 3	
...	...	...	...	...	...	...	...	...	...	78 3 0	
...	...	...	...	...	...	...	...	...	...	389 9 9	
...	...	...	...	...	...	...	...	...	...	267 10 0	
...	...	...	...	...	...	...	...	...	...	392 12 6	
...	...	...	...	...	...	...	...	...	...	105 9 6	
...	...	...	...	...	...	...	...	...	...	43 15 0	
...	...	...	...	...	...	...	...	...	...	52 12 9	
...	...	...	...	...	...	...	...	...	...	304 4 0	
...	...	...	...	...	...	...	...	...	...	1,557 11 9	
...	...	...	...	...	...	...	...	...	...	1,287 8 6	
...	...	...	...	...	...	...	...	...	...	1,292 6 9	*5 Plates reprinted.

PHOTOGRAPHIC

Statement of Departmental Work done

Specification of Plate or Print.	Scale of Map.		Sheets or subjects.	Negatives.		Photozincographic Printing.				
	Original.	Reproduced.		Direct negatives.	Reversed negatives and transparencies.	Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Pulls.	Copies.
Standard Maps—*concld.*	In. M.	In. M.								
Punjab—										
District Hazara—										
Sheets Nos. 11, 14 and 15										
District Hissar—										
Sheet No. 241										
Districts Hoshiarpur and Jullundur—										
Sheet No. 267										
Districts Hoshiarpur, Umballa, and Patiala State—										
Sheet No. 290										
Districts Jullundur, Ludhiana and Umballa—	2=1									
Sheet No. 269	1=1	1=1	53	55	...	59*	15	...	...	...
District Ludhiana and Sikh States—										
Sheets Nos. 253 and 270										
District Umballa, Kalsia and Patiala Native States—										
Sheet No. 291										
District Umballa, and Kalsia Native State—										
Sheet No. 314										
District Umballa, and Patiala State—										
Sheet No. 292										
District Umballa—										
Sheets Nos. 289, 313, and 336										
District Hoshiarpur—										
Sheet No. 266	2=1	1=1	4	4	...	4	1	1	150	150
District Hissar—										
Sheet No. 261										
Districts Jullundur and Ludhiana—	...	1=1	...	...	...	...	...	3	375	375
Sheets Nos. 252 and 268										
District Ludhiana and Sikh States—										
Sheet No. 253 (South Sheet)	2=1 1=1	1=1	5	6	...	...	...	...	...	...
District Rawalpindi—										
Sheet No. 160 $\frac{\text{N. E.,}}{2,3,4}\ \frac{\text{S. E.}}{1,2,3,4}$										
„ „ 161 $\frac{\text{N. E.,}}{1,2,3}\ \frac{\text{S. E.}}{2,3,4}$										
„ „ 162 $\frac{\text{N. E.}}{1,2,3,4}$	...	4=1	...	...	...	...	...	25	3,750	3,750
„ „ 185 $\frac{\text{S. W.}}{2,3,4}$										
„ „ 186 $\frac{\text{N. W.}}{1,2,3,4}\ \frac{\text{S. W.}}{1,2,3,4}$										
„ „ 161 $\frac{\text{N. E.,}}{4}\ \frac{\text{S. E.}}{1}$										
„ „ 184 $\frac{\text{N. W.,}}{1,3,4}\ \frac{\text{S. W.}}{1,2,3,4}$	4=1	4=1	9	36	...	36	9	...	...	...
„ „ 185 $\frac{\text{N. W. and}}{1,2,3}\ \frac{\text{S. W.}}{1}$										
Upper Burma (S. E. Trans-frontier Series)—										
Reconnaissance Maps—										
Sheet No. 1 N.E., S.E.										
„ „ 2 N.E., S.E. 3 N.E. (1st and 2nd editions)	1=4	1=4	12	45	...	57†	12	9	2,270	2,270
„ „ 4 S.W., 5 N.W., S.W.										
„ „ 6 N.W.										
Total	...	...	270	528	...	540	138	167	25,163	25,163
Index Maps.										
Of various Survey operations and Standard Sheets	...	...	38	42	...	41	27	54	16,321	16,501
Total	...	...	38	42	...	41	27	54	16,321	16,501
Technical Charts.										
Triangulation chart of Baluchistan Topographical Survey	3=1	1=2	1	1	...	1	1	1	25	25
Triangulation chart of Central Provinces Survey	...	1=4	...	...	...	...	...	3	75	75
Triangulation charts of Central Provinces, and Ganjam and Orissa	4=1	4=1	2	8	...	8	2	...	...	...
Triangulation charts of Chindwin and Kubo Valleys	1=4	Half	2	2	...	2	1	1	30	30
Plan of the Trigonometrical operations in the Nizam's Dominions extending from Kurnool to the Godavari.	1=8	1=8	1	2	...	2	1	...	...	...
Total	...	...	6	13	...	13	5	5	130	130
Miscellaneous Maps and Plans.										
Afghanistan—										
Sheets Nos. N.E. and N. W. Sections (outline and hills)	1=24	...	4	4	...	4	4	...	...	...
Afghanistan, portion of	1=24	...	1	2	...	2	1	...	...	...
Ditto Map, N. E. Section	...	...	2	2	...	...	...	...	...	...
Akyab District	1=4	Half	2	2	...	2	1	1	62	62

OFFICE, CALCUTTA.

during the year 1887-88—continued.

Silver and other Printing.			Heliogravure and Electrotyping.					Photocollotype.			
Silver prints.	Blue prints.	Miscellaneous prints.	Plates photo-electro-typed.	Plates photo-etched.	Prints.	Photo-blocks.	Electro-types.	Plates.	Prints.	Value.	Remarks.
										R a. p.	
...	...	...	...	...	...	...	...	...	...	769 7 3	*4 Transfers from old negatives.
...	...	...	...	...	...	...	...	...	...	93 11 9	
...	...	...	...	...	...	...	...	...	...	115 0 9	
...	...	...	...	...	...	...	...	...	...	38 13 6	
...	...	...	...	...	...	...	...	...	...	1,047 7 0	
...	...	...	...	...	...	...	...	...	...	476 6 3	
...	...	...	...	...	...	...	...	...	...	1,272 2 9	1 S.E. re-done. †12 Transfers from old negatives.
...	...	...	...	...	...	...	...	...	...	14,028 0 3	
...	...	...	...	...	...	...	...	...	...	1,876 8 9	
...	...	...	...	...	...	...	...	...	...	1,876 8 9	
...	...	...	...	...	...	...	...	...	...	24 13 0	
...	...	...	...	...	...	...	...	...	...	27 5 9	
...	...	...	...	...	...	...	...	...	...	104 6 3	
...	...	...	...	...	...	...	...	...	...	36 8 0	
...	...	...	...	...	...	...	...	...	...	31 3 0	
...	...	...	...	...	...	...	...	...	...	224 4 0	
...	...	...	...	...	...	...	...	...	...	74 6 3	
...	...	...	...	...	...	...	...	...	...	29 1 6	
...	...	...	...	...	...	...	...	...	...	14 6 3	
...	...	...	...	...	...	...	...	...	...	40 14 6	

PHOTOGRAPHIC

Statement of Departmental work done

Specification of Plate or Print.	Scale of Map.		Sheets or subjects.	Negatives.		Photozincographic Printing.				
	Original.	Reproduced.		Direct negatives.	Reversed negatives and transparencies.	Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Pulls.	Copies.
Miscellaneous Maps and Plans—*contd.*										
Aperçu General de la Division Administrative des Provinces Asiatiques de l' Empire Ottoman, &c., and Reconnaissance Map of North and North-Western China.	...	...	...	...	...	...	...	...	30	30
Architectural Plates, Dr. Burgess' Report, 12 plates	...	...	...	...	...	...	...	...	...	...
Ballia, Route to and from	1=1	1=1	1	2	...	2	1	1	50	50
Baluchistan Survey	2=1	...	14	14	...	...	...	...	...	...
Baroda City—										
Sheet No. 7	...	...	1	1	...	1	1	...	...	...
Baroda State—										
Sheet No. 108	4=1	Half	1	4	...	4	1	1	45	45
Benares, City and Cantonments of—										
Sheets No. 2 S. E. S. W. and N. W.										
,, ,, 3 N. E. and S. E.	32=1	Half	11	19	...	19	10	...	...	2a
,, ,, 4 N. W. and S. W.										
,, ,, 21 N. E., N. W., S. E., and S. W.										
Bengal, Behar, and Orissa, Sketch Map of	...	...	...	...	...	...	...	2	200	200
Bogra and Pubna Districts—										
Sheets Nos. 3, 4, 6, and 8	1=1	1=1	6	18	...	18	8	8	320	320
Bombay Presidency showing Abkari system	...	...	...	...	...	...	...	...	125	125
Boundary between Garo Hills and Mymensingh	2=1	...	2	8	...	8	2	2	82	82
Budaun District	...	...	...	...	...	...	...	2	200	200
Burma (Upper)	...	...	...	...	...	1	1	...	...	...
Burma (Lower)—										
Sheet No. 111 N.-W.	4=1	1=1	1	1	...	...	...	...	...	...
Dacca District, Main Circuit Map of										
Sheets Nos. 3 to 9 and 13 and 14	1=1	1=1	8	20	...	20	7	7	250	250
Electrotypes—										
India, Map of (Matrix)	1=32	1=32	...	...	...	...	...	...	...	...
India, Map of, Sheet No. 1	...	...	...	...	...	...	...	...	...	...
Ditto ditto, Sheets Nos. 2, 4, and 6 (Matrix)	1=32	...	3	...	...	...	...	...	...	...
North-West Provinces and Oudh, Provincial Map of	...	...	...	...	...	...	...	...	...	...
North-West Provinces and Oudh, Province of	...	...	...	...	...	...	...	...	...	...
Quarter Atlas Sheets Nos. 76 N. E. and 77 N. W.	...	...	2	...	...	...	...	...	...	...
Do. do. 79 S. W. (Matrix)	...	...	1	...	...	...	...	...	...	...
Elephant Catching	...	...	...	...	...	...	...	...	...	...
General Arrangement of 8½′ × 5′, Willan's Central Valve Engine	...	...	1	1	...	...	...	...	...	...
General Plan of the operations at Lucknow	...	...	1	4	...	4	1	1	25	25
Gorakhpur Municipal Map	...	...	...	...	...	...	...	...	400	400
Hazara Field Force, Map illustrating the operations of, in 1868	2=1	Half	2	2	...	2	1	1	100	100
Headings for Maps	...	...	3	1	...	1	...	...	...	...
Hooghly River Survey—										
Sheets Nos. 3 to 8 (Port Commissioners' Map)	...	...	19	19	...	...	...	...	...	...
,, ,, 1 to 9 (Revenue Map)										
From Calcutta to Saugor, Sheets Nos. 1, 2 and 3	...	...	...	...	...	...	...	...	15	15
India, Railway Map of	1=32	1=32	...	...	...	...	...	1	12	12
India, showing feeders to Railways, Sheets Nos. 2, 4, 5 and 6	...	...	...	...	...	...	...	5	92	92f
India, showing Railways open to traffic, under construction, and under survey.	...	...	...	...	...	...	...	1	190	100
Jeypore, Map of	...	...	...	...	...	...	...	...	50	50
Kalinjar Town, plan of	3= 1	1½ double.	1	2	...	...	...	...	...	...
Litho. and Photo. Offices, plan of	...	...	2	8	...	8	5	8	60	60
Mathematical Instrument Office, plan of	...	...	...	...	...	3g	2	2	24	36
Ditto (*old*), Photo. of	...	...	...	...	...	...	...	...	...	...
Ditto (*new*), Do.	...	...	1	2	...	...	...	...	...	...
Moradabad District	...	...	...	...	...	...	...	2	200	200
Mysore Compilation	...	...	...	...	...	...	...	1	100	100
Ortho-chromatic plate of water-color drawing	...	...	...	...	3	...	...	...	...	...
Panoramic views to illustrate report on Trans-Caspian, by Colonel Le Messurier, R.E., and Plate No. 6.	...	...	...	...	...	...	...	...	...	...
Plane table, with original field work, by Mr. Ogle	1= 4	1= 4	1	1	...	...	...	...	...	...
Portrait of Her Majesty the Queen	...	...	...	...	...	...	...	...	...	...
Prome District Township Mathaban	16= 1	½	22	22	...	...	...	...	...	...
Punchanagram, Map of	1=100ft.	Full.	4	3	...	3	1	1	25	25
Quarter Atlas Sheet No. 14 S. W.	...	...	1	...	...	...	...	...	...	...
Reduction of Standard sheets to Atlas scale	...	...	60	64	1	4	1	...	...	...
Scientific American Supplement for January 1888, pages 10366-7	...	...	1	1	...	1	...	...	...	...
Sitabaldi Fort, plan of	...	...	...	...	...	...	...	...	15	15

OFFICE, CALCUTTA.

during the year 1887-88—continued.

Silver and other Printing.			Heliogravure and Electrotyping.				Photocollotype.			Value.	Remarks.
Silver prints.	Blue prints.	Miscellaneous prints.	Plates photo-electro-typed.	Plates photo-etched.	Prints.	Photo blocks.	Electro-types.	Plates.	Prints.		
										R. a. p.	
...	...	...	...	...	...	...	...	...	...	6 14 9	For record in Map Record and Issue Office.
...	...	...	...	...	300	...	...	...	...	.....	For record in Photo Office.
...	...	...	...	...	...	...	...	...	...	40 3 6	
...	56	...	...	...	...	...	...	...	...	112 12 9	
...	...	...	...	...	...	...	...	...	...	11 6 3	
...	...	...	...	...	...	...	...	...	...	57 15 0	
...	...	...	...	...	...	...	...	...	...	279 4 9	*a* Tracing prints.
...	...	...	...	...	...	...	...	...	...	84 1 3	
...	...	...	...	...	...	...	...	...	...	348 10 9	
...	...	...	...	...	...	...	...	...	...	11 8 3	For record in M. R. & I. O.
...	...	...	...	...	...	...	...	...	...	121 10 3	
...	...	...	...	...	...	...	...	...	...	50 4 6	
...	...	...	...	...	...	...	...	...	...	7 3 3	
...	4	...	...	...	...	...	...	...	...	9 14 3	
...	...	...	...	...	...	...	...	...	...	349 14 6	
...	...	...	...	...	...	...	1*b*	...	...	324 0 0	*b* (Duplicate.)
...	...	...	...	...	...	...	1*c*	...	...	243 0 0	*c* (Duplicate.)
...	...	...	...	...	...	...	3	...	...	688 8 0	
...	...	...	...	...	...	...	1	...	...	32 6 3	
...	...	...	...	...	...	...	1*d*	...	...	32 6 3	*d* (Matrix.)
...	...	...	...	...	...	...	2	...	...	291 9 6	(Do.)
...	...	...	...	...	...	...	1*e*	...	...	145 12 9	*e* (Duplicate).
18	...	...	...	...	...	...	...	...	...	14 6 3	For record in Photo Office.
...	6	...	...	...	...	...	...	...	...	13 10 6	
...	...	...	...	...	...	...	...	...	...	61 8 0	
...	...	...	...	...	...	...	...	...	...	76 0 9	For record in M. R. & I. Office.
...	...	...	...	...	...	...	...	...	...	46 9 3	
...	...	...	...	...	...	...	...	...	...	8 6 3	
...	38	...	...	...	...	...	...	...	...	118 3 9	
...	...	...	...	...	...	...	...	...	...	4 10 6	For record in M. R. & I. Office.
...	...	...	...	...	...	...	...	...	...	6 7 0	Reprint.
...	...	...	...	...	...	...	...	...	...	33 1 9	*f* 31 copies reprinted.
...	...	...	...	...	...	...	...	...	...	26 3 3	
...	...	...	...	...	...	...	...	...	...	9 9 0	For record in M. R. & I. Office.
...	...	...	...	...	...	...	...	...	...	13 8 0	
...	...	...	...	...	...	...	...	...	...	186 10 3	
...	...	...	...	...	...	...	...	...	...	38 1 3	*g* Taken from old negatives.
6	...	...	...	...	...	...	...	...	...	5 6 6	
14	...	...	...	...	...	...	...	...	...	31 3 3	
...	...	...	...	...	..	...	...	...	...	54 10 6	Reprint. For record in M. R. & I. Office.
...	...	...	...	—	...	...	...	...	...	25 12 0	
...	...	...	...	2	4*j*	...	...	...	553	70 12 9	*j* Pigment prints for Annual Report.
165	...	...	...	...	...	...	...	...	...	195 4 9	For record in Drawing, Photo. & Dehra Offices.
12	1	...	...	...	...	...	...	...	...	55 12 9	
...	...	...	...	...	525	...	...	...	...	69 0 0	For Annual Report.
...	44	...	...	...	...	...	...	...	...	118 12 9	
...	...	...	...	...	...	...	...	...	...	53 8 6	
...	...	...	...	2	2*	...	...	...	...	66 0 0	* Pigment prints.
...	240	...	2	...	6†	...	...	...	...	831 9 3	† 2 Do. do.
...	...	...	...	...	...	...	...	...	...	16 12 9	
...	...	...	...	...	...	...	...	...	...	4 5 3	For record in M. R. and I. Office.

Statement of Departmental Work done

Specification of Plate or Print.	Scale of Map.		Sheets or subjects.	Negative.		Photozincographic Printing.				
	Original.	Reproduced.		Direct negatives.	Reversed negatives and transparencies.	Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Pulls.	Copies.
Miscellaneous Maps and Plans—*concld.*	In. M.	In. M.								
Specimen of sizes of symbols, letters, &c., for N. W. Trans-frontier sheet.	...	...	1	1	...	1	1	...	...	...
Specimen of symbols used in quarter-inch sheet, N. W. Trans-frontier.	...	...	1	1	...	...	...	...	...	...
Specimen of type used in the production of Ordnance Survey Maps	...	...	1	1	...	1	1	...	...	...
Tipperah District, Main Circuit Maps of, Sheets Nos. 4, 5, 6, 7, 11 and 12.	1 = 1	1 = 1	5	14	...	14	8	8	400	400
Trans-frontier sheets—										
N. E. Trans-frontier sheets	1 = 4	Full and half.	12	14	...	...	...	...	...	...
N. W. do. do.	...	...	30	32	...	14	2	...	...	...
Various Plates	...	...	...	...	...	...	...	...	...	...
Vernacular titles for Cadastral Maps	...	...	...	...	...	...	...	...	...	...
Experimental work—										
Heliogravure	...	...	7	14	13	...	...	...	...	...
Photo-collotype	...	...	1	...	2	...	...	...	...	...
Making Tracing Prints	...	...	...	...	...	...	...	...	...	...
Total	...	...	237	304	19	137	61	55	3,072	2,996
Abstract of Departmental Maps.										
General Maps	...	...	8	20	...	20	7	24	1,982	1,982
Provincial Maps	...	...	3	8	...	11	4	7	2,094	2,094
Divisional Maps	...	...	15	16	...	16	5	5	205	205
District Maps	...	...	3	9	...	9	3	3	700	1,400
Plans of Cities and Cantonments	...	...	47	70	...	68	10	4	400	400
Atlas Sheets	...	...	1	...	...	...	...	...	...	...
Standard Sheets	...	...	270	528	...	540	138	167	25,163	25,163
Index Maps	...	...	38	42	...	41	27	54	16,321	16,501
Technical Charts	...	...	6	13	...	13	5	5	130	130
Miscellaneous Maps and Plans	...	...	237	304	19	137	61	55	3,072	2,996
Transfers and proofs	...	...	...	...	...	...	...	...	1,598	...
TOTAL	...	...	628	1,010	19	855	260	324	51,665	50,871
Cadastral Maps.										
North-West Provinces—										
Photozincographs	...	...	1,591	1,591	...	1,587	1,636	1,636	32,331	32,331
Zincographs	...	...	454	...	...	...	454	454	9,298	9,298
Total	...	...	2,045	1,591	...	1,587	2,090	2,090	41,629	41,629
Burma—										
Photozincographs	...	...	916	916	...	906	839	839	28,424	28,424
Zincographs	...	...	210	...	...	...	210	210	7,652	7,652
Total	...	...	121	916	...	906	1,049	1,049	36,076	36,076
Assam—										
Photozincographs	...	...	464	464	...	460	523	523	24,573	24,573
Zincographs	...	...	235	...	...	...	235	235	12,455	12,455
Total	...	...	699	464	...	460	758	758	37,028	37,028
Transfers and proofs	...	...	...	...	...	...	...	...	7,188	...
TOTAL	...	...	3,870	2,971	...	2,953	3,897	3,897	121,921	114,733

OFFICE, CALCUTTA.

during the year 1887-88—concluded.

Silver and other Printing.			Heliogravure and Electrotyping.					Photocollotype.		Value.	Remarks.
Silver prints.	Blue prints.	Miscellaneous prints.	Plates photo-electro-typed.	Plates photo-etched.	Prints.	Photo.-Block.	Electro-types.	Plates.	Prints.		
										R a. p.	
...	...	...	...	...	...	...	...	...	...	15 9 6	
...	3	...	...	...	...	...	...	...	...	13 10 6	
...	...	...	...	...	...	...	...	...	...	13 3 3	
...	...	...	...	...	...	...	...	...	...	337 12 9	
...	48	...	...	...	...	...	...	...	...	150 9 3	
...	48	...	...	...	...	...	...	...	...	294 4 9	
...	...	...	...	...	50	...	...	...	...	...	For Office use.
...	...	...	...	3	...	...	...	...	...	27 9 6	
...	4	...	1	16	33*	...	2	...	...	583 7 3	* 21 Pigment prints.
...	...	...	...	...	...	...	...	9†	53	120 13 9	† 2 bitumen plates.
...	...	...	...	...	...	...	...	...	...	113 12 3	
215	492	...	3	23	920	...	12	9	606	7,334 14 9	
...	...	...	...	...	...	...	...	...	...	891 12 3	
...	...	...	...	...	...	...	1	...	...	593 3 9	
...	...	...	...	...	...	...	...	...	...	235 10 9	
...	...	...	...	...	...	...	...	...	...	181 11 0	
...	...	...	...	...	...	...	...	...	...	873 12 6	
...	...	...	1	...	...	...	...	...	...	145 12 9	
...	...	...	...	...	...	...	...	...	...	14,028 0 3	
...	...	...	...	...	...	...	...	...	...	1,876 8 9	
...	...	...	...	...	...	...	...	...	...	224 4 0	
215	492	...	3	23	920	...	12	9	606	7,334 14 9	
...	...	...	...	...	...	...	...	...	...	...	
215	492	...	4	23	920	...	13	9	606	26,385 0 9	
...	...	...	...	...	...	...	...	...	...	25,027 12 9	
...	...	...	...	...	...	...	...	...	...	4,754 14 0	
...	...	...	...	...	...	...	...	...	...	29,782 10 9	
...	...	...	...	...	...	...	...	...	...	14,169 5 0	
...	...	...	...	...	...	...	...	...	...	2,380 8 0	
...	...	...	...	...	...	...	...	...	...	16,549 13 0	
...	...	...	...	...	...	...	...	...	...	11,541 11 0	
...	...	...	...	...	...	...	...	...	...	3,496 0 0	
...	...	...	...	...	...	...	...	...	...	15,037 11 0	
...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	61,370 2 9	

Statement of work done for other Departments, &c., during the year 1887-88.

Department, &c.	Sheets or Subjects.	Negatives.		Photozincographic Printing.					Silver and other Printing.			Heliogravure and Electrotyping.					Photo-collotype.		Value.	Remarks.
		Direct Negatives.	Reversed Negatives and transparencies.	Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Pulls.	Copies.	Silver prints.	Blue prints.	Miscellaneous prints.	Plates photo-electrotyped.	Plates photo-etched.	Prints.	Photo-blocks.	Electrotypes.	Plates.	Prints.		
																			R a. p.	
Asiatic Society of Bengal	3	3	4	...	1	1	294	588	...	4	...	...	1	1	...	...	15	3,606	1,010 2 9	
Archæological Survey of India	133	93	25	29	5	...	...	...	28	156	...	10	13	3,731	...	...	1	32	2,996 5 9	
Ditto Bengal	...	...	...	...	...	...	...	...	12	...	...	...	...	...	...	...	...	...	7 1 6	
Agent and Chief Engineer, Bengal Central Railway Company	...	...	...	...	1	1	200	200	...	...	...	...	...	...	...	...	...	...	26 5 9	
Board of Revenue, Bengal	2	3	...	11	11	10	3,250	3,450	...	...	...	...	...	...	...	...	...	...	394 4 9	
Ditto North-Western Provinces	10	34	...	34	8	4	800	800	...	...	...	...	...	...	...	...	...	...	645 9 0	
Bombay Natural History Society	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	631	150 0 0	
Calcutta Municipality	3	11	...	11	3	3	600	600	...	...	...	...	...	...	...	...	...	...	313 0 9	
Chief Engineer, Bengal, Public Works Department	9	28	...	28	11	9	750	750	...	...	...	...	...	...	...	...	...	...	614 3 6	
Ditto Rajputana-Malwa Railway	1	1	...	1	1	1	50	50	...	...	...	...	...	...	...	...	...	...	25 2 9	
Ditto Kashmir State	3	14	...	13	5	7	120	120	...	13	...	...	...	...	...	...	...	...	274 5 0	
Consulting Engineer, Lucknow	...	...	...	8	2	2	804	2,010	...	...	...	...	...	402	...	...	...	...	160 1 0	
Chief Commissioner, Burma	1	1	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	12 0 0	
Director General of Railways	5	13	...	27	6	14	6,677	4,397	...	...	...	...	...	...	...	...	...	...	1,137 15 3	
Ditto Telegraphs in India	2	2	...	...	...	...	...	...	...	4	...	...	...	...	...	...	...	...	17 13 6	
Director, Geological Survey of India	...	...	1	1	...	...	...	...	...	...	...	...	1	2	...	...	...	...	53 3 6	
Director of the Department of Land Records and Agriculture, Bengal	...	...	...	...	5	5	1,800	2,100	...	...	...	...	...	...	...	...	...	...	246 5 9	
Deputy Surgeon General, Central Provinces	1	1	...	1	1	1	275	275	...	...	...	...	...	...	...	...	...	...	44 8 9	
Deputy Quarter Master General, Mandalay	...	...	...	...	...	4	400	400	...	...	...	...	...	...	...	...	...	...	78 15 9	
Deputy Commissioner of Mandalay	21	41	...	41	21	11	1,140	1,140	...	...	...	...	...	...	...	...	...	...	890 2 9	
Ditto Pyanmana	...	...	...	...	...	2	29	29	...	...	...	...	...	...	...	...	...	...	13 9 3	
Executive Engineer, Quetta Division	...	...	...	...	...	1	140	140	...	...	...	...	...	...	...	...	...	...	51 10 0	
Ditto Jeypur	6	3	2	8	1	1	100	100	...	...	...	2	...	20	...	...	...	...	375 15 0	
Ditto Bannu Railway Survey	3	3	3	...	...	...	...	...	...	...	...	...	3	205	...	...	...	...	182 6 6	
Government of India, Revenue and Agricultural Department	1	1	...	...	...	...	...	...	...	1	...	...	1	2	...	...	...	...	53 6 3	
Ditto ditto (Technical Art Series)	2	...	...	...	6	5	886	965	...	...	...	6	...	2,531	...	...	...	...	824 8 6	

Ditto Foreign Department	10	10	...	...	...	...	...	...	356	...	...	...	...	...	...	...	...	...	908 1 3
Ditto Military Department	4	3	...	2	2	2	60	60	...	1	...	...	...	...	...	...	...	...	43 0 3
Ditto Public Works Department	162	173	...	175	69	41	5,410	9,264	...	...	...	...	...	...	...	...	...	...	3,391 12 3
Government of Bengal, Legislative Department	1	1	...	1	1	1	130	130	...	...	...	...	...	...	...	...	...	...	29 11 0
Ditto Public Works Department	12	10	...	10	5	5	500	1,300	...	...	...	...	...	...	...	...	...	...	224 4 9
Government of North-Western Provinces and Oudh, P. W. D.	66	66	...	66	19	19	5,320	17,840	...	...	...	...	...	...	...	...	...	...	1,673 2 9
Government of Punjab, Revenue Department	19	52	...	52	15	20	3,250	3,250	...	...	...	...	...	...	...	...	...	...	1,715 2 0
Ditto Public Works Department	27	39	...	39	12	13	1,575	2,575	...	...	...	...	...	...	...	...	...	...	760 14 6
General Officer Commanding Hyderabad Contingent	2	8	...	8	2	...	...	...	...	...	...	...	...	...	...	...	...	...	108 0 0
Ditto Burma Field Force	...	...	...	...	...	7	630	630	...	...	...	...	...	...	...	...	...	...	115 0 0
Gorakhpur Municipality	...	...	...	...	...	4	400	400	...	...	...	...	...	...	...	...	...	...	87 9 0
Inspector-General of Military Works	31	48	...	48	15	13	5,200	9,700	...	...	...	...	...	...	...	...	...	...	1,868 3 9
India Office, London	...	...	...	...	...	6	600	600	...	...	...	...	...	...	...	...	...	...	51 1 9
Indian Museum	...	...	...	...	...	...	...	...	9	...	...	...	...	...	...	...	...	...	8 2 0
Marine Survey of India	...	...	...	...	...	1	45	45	...	...	...	...	...	...	...	...	...	...	21 14 0
Manager, Eastern Bengal State Railway	3	12	...	12	4	8	500	500	...	...	...	...	...	...	...	...	...	...	306 8 0
Ditto North-Western Railway	...	...	...	...	...	1	1,010	2,020	...	...	...	...	...	...	...	...	...	...	149 11 0
Meteorological Reporter, Government of India	6	6	...	6	3	6	2,830	7,650	...	...	...	1	...	...	...	...	...	...	894 7 6
Mint Master, Calcutta	1	1	1	...	...	...	...	...	...	...	...	...	1	81	...	...	...	...	60 0 0
Port Commissioners, Calcutta	5	17	...	17	7	10	1,165	1,165	...	...	...	...	...	...	...	...	...	...	560 11 0
Quarter Master General in India	121	135	15	68	31	48	7,766	6,862	676	1	...	...	16	1,617	...	...	...	...	4,338 7 6
Ditto Madras	7	16	...	16	6	6	1,615	1,615	...	...	...	...	...	...	...	...	...	...	553 15 9
Secretary to the Chief Commissioner, Central Provinces	59	...	...	...	...	...	...	...	59	...	...	...	...	...	...	...	...	...	44 4 0
Ditto Financial Commissioner, Punjab	...	...	...	...	4	4	2,080	520	...	...	...	...	...	...	...	...	...	...	181 4 3
Sanitary Commissioner, Government of India	...	...	...	...	...	...	...	...	...	...	...	...	...	600	...	...	...	...	85 14 0
Ditto Government of Bengal	...	...	...	...	2	2	830	830	...	...	...	...	...	...	...	...	...	...	187 4 6
Ditto Assam	...	...	...	...	...	4	1,010	505	...	...	...	...	...	...	...	...	...	...	123 5 9
Superintendent of Works, Calcutta	15	8	...	8	4	1	50	50	...	...	...	...	...	...	...	...	...	...	145 14 6
Ditto Carriage-Wagon Department, East Indian Railway	24	27	...	27	8	8	401	1,201	...	...	...	...	...	...	...	...	...	...	373 3 9
Ditto ditto Rajputana-Malwa Ry.	2	4	...	4	2	2	2,000	2,000	...	...	...	...	...	...	...	...	...	...	393 13 3
Ditto Botanical Gardens	...	...	...	...	...	1	54	...	...	...	...	...	...	...	...	...	1	54	30 5 6
Ditto Telegraph Stores	1	1	...	1	1	1	400	400	...	...	...	...	...	...	...	...	...	...	21 15 3
Ditto Kheddahs	32	...	...	...	...	...	...	...	281	...	...	...	...	...	...	...	...	...	237 14 0
Superintending Engineer, Central Provinces	2	9	...	9	3	3	60	60	...	...	...	...	...	...	...	...	...	...	151 4 6
Superintendent of Forest Surveys	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6 7 3
Special work done for Trade and Private Individuals	22	22	...	20	2	4	821	836	135	...	...	...	...	650	...	...	...	...	584 0 6
TOTAL	842	921	51	798	306	323	64,127	91,122	1,556	180	...	19	36	9,842	...	...	21	4,323	31,035 14 3*

* NOTE.—Of this amount R3,318-0-9 have been charged for in cash, R23,820-0-3 by book debit, and R1,807-4-3 are charged against the Survey Department under Financial Resolution No. 666, dated 9th February 1888.

PHOTOGRAPHIC OFFICE, CALCUTTA.

Statement showing Expenditure (Dr.) and Value of Work done (Cr.) during the year 1887-88.

DR.	R	a.	p.	R	a.	p.		R	a.	p.	R	a.	p.
NORMAL ESTABLISHMENT.							Departmental Maps and Plans	26,385	10	9			
Superintendent's salary	5,316	2	1				Miscellaneous maps and plans, Extra Departmental	31,035	14	3	57,421	9	0
Assistant Superintendent's salary	2,800	0	0	8,116	2	1							
Establishment	31,842	14	11				Cadastral maps, N.-W. Provinces	29,782	10	9			
Rent of Office and Taxes	4,542	7	0				Ditto Burma	16,549	13	0			
Contingencies	1,556	4	6	37,941	10	5	Ditto Assam	15,037	11	0	61,370	2	9
Special grant	37	6	0	37	6	0	Old tin and packing cases sent to the Mathematical Instrument Office	79	8	0			
CADASTRAL ESTABLISHMENT.							Articles and stores supplied to the other offices of the Survey of India Department	3,428	3	9	3,507	11	9
Superintendent's salary	5,316	2	1				Stores supplied to private individuals	6	12	0	6	12	0
Assistant Superintendent's salary	2,800	0	0	8,116	2	1							
Establishment	34,257	3	10				Sale of unserviceable articles	53	5	9			
Rent of Office and Taxes	3,439	5	4				Pure silver recovered from silver residues	923	6	5	976	12	2
Contingencies	4,210	9	10	41,907	3	0							
Chemicals and stores received from England	11,416	1	9										
Printing paper and cloth received from England	6,968	1	0	18,384	2	9							
Stores received from the Mathematical Instrument Office	23	9	0										
Articles repaired at Mathematical Instrument Office	172	3	0	195	12	0							
Work done by the Lithographic Office	2,158	12	0										
Printing paper and stores received from Litho. and Engraving Offices	577	9	3	2,736	5	3							
Stores and materials received from the Stationery Office	197	6	1										
Printing paper and cloth received from the Stationery Office	2,076	4	0	2,273	10	1							
Work done and articles supplied by other Departments	758	11	11	758	11	11							
Balance in favour	...			2,815	14	1							
TOTAL	...			1,23,282	15	8	TOTAL	...			1,23,282	15	8

LITHOGRAPHIC AND PRINTING OFFICE, CALCUTTA.

Statement of work done for other Departments, &c., during the year 1887-88.

Departments, &c.	Lithographic Printing.				Total pulls.	Total copies.	Value.	Remarks.
	Sheets or subjects.	Stones.	Coloured copies.	Uncoloured copies.			R a. p.	
Archæological Survey of India	26	24	...	16,880	15,540	16,880	1,212 10 0	
	2	2	...	..	...	...	27 4 0	Not yet printed.
Asiatic Society of Bengal	7	2	...	5,510	1,910	5,5 0	198 12 0	
Adjutant-General in India	1	1	...	150	150	150	32 14 6	
Board of Revenue, Lower Provinces	12	12	1,985	2,430	4,005	4,415	865 7 0	
Calcutta Municipality	8	6	...	4,105	3,105	4,105	432 15 0	
Central Provinces Administration	1	1	...	270	270	270	14 8 0	
Ditto Settlement and Agricultural Department.	3	3	...	3,000	3,000	3,000	535 9 0	
Chief Commissioner, Burma	1	2	385	...	770	385	81 9 0	
Consulting Engineer, Government of India, for Railways.	14	9	105	917	1,120	1,022	331 0 0	
Director-General of Railways	1	2	55	...	110	55	80 15 0	
	3	3	...	...	...	...	148 4 0	Not yet printed.
Director-General of Post Offices	1	1	...	...	...	...	188 4 0	Not yet printed.
Director of Agriculture, Bengal	1	1	...	125	125	125	32 11 0	
Director of Military Education in India.	4	4	880	...	1,060	880	299 7 0	
Director of Public Instruction, Bengal	4	2	2,220	...	1,110	2,220	205 0 0	
Executive Engineer, Pishin Irrigation Division	1	1	...	24	24	24	4 8 0	
Engineer-in-Chief, Chenab Bridge Works.	1	1	...	50	50	50	3 11 0	
Geological Survey of India	5	11	2,095	1,530	8,055	3,625	899 15 0	
	1	1	...	...	...	...	132 1 0	Not yet printed.
Government of Bengal	21	15	1,080	8,972	7,699	10,052	814 12 0	
	4	4	...	...	...	...	187 12 0	Not yet printed.
Ditto, Public Works Department.	9	...	...	...	...	...	151 3 0	Drawing charge only.
Government of India, Financial Dept.	2	2	...	855	855	855	112 3 0	
Ditto, Home Dept.	5	3	...	169	96	169	83 5 0	
Ditto, P. W. Dept.	46	14	...	2,359	1,007	2,359	455 0 0	
	3	9	...	...	...	...	421 7 0	Not yet printed.
Ditto, Military Dept.	6	4	...	4,220	4,160	4,220	442 10 0	
Ditto, Revenue and Agricultural Department.	22	19	322	4,117	4,556	4,439	873 8 0	
	3	2	...	...	...	...	20 1 0	Not yet printed.
Ditto, Foreign Dept.	50	37	...	2,660	2,092	2,660	1,280 3 0	
Government of Punjab	2	2	...	580	580	580	135 4 0	
Ditto, P. W. Dept., Irrigation Branch.	1	1	...	4,000	4,000	4,000	399 10 0	
Ditto, Finance Department.	7	8	1,350	200	1,875	1,550	273 6 0	
Government of North-Western Provinces and Oudh, P. W. Dept., Irrigation Branch.	1	2	1,005	...	2,010	1,005	373 2 0	
General Superintendent, Horse-Breeding Department, India.	1	3	165	...	495	165	156 8 0	
	1	3	...	...	...	...	112 12 0	Not yet printed.
Inspector-General of Police, Bengal	4	2	1,500	...	750	1,500	108 13 0	
Ditto of Registration, Bengal.	1	3	400	...	1,200	400	73 6 0	
Master of the Mint, Calcutta	7	2	...	560	160	560	100 12 6	
Meteorological Reporter, India	49	36	2,655	113,445	110,805	116,100	3,703 10 0	
	1	1	...	...	...	...	11 6 0	Not yet printed.
Ditto ditto, Bengal	4	6	1,420	25,500	28,340	26,920	523 6 0	
Ditto ditto, Western India.	1	1	...	500	500	500	20 2 0	
Military Secretary to the Viceroy	9	1	...	1,530	170	1,530	25 12 0	
Miscellaneous maps, plans, &c.	8	8	...	4,225	3,925	4,225	467 10 0	
Ordnance Department, India	5	1	...	1,020	204	1,020	67 3 0	
Officer in charge Nicobar Islands	1	1	...	1,105	1,105	1,105	71 14 0	
Principal Medical Store-keeper to Government.	1	1	...	200	200	200	25 2 0	
Public Service Commission	7	6	505	3,210	3,120	3,715	518 13 0	
Port Officer and Registrar of Wrecks	2	4	155	155	620	310	181 4 6	
Quarter-Master-General in India	53	38	305	8,670	7,382	8,975	2,519 3 0	Not yet printed.
	6	12	...	...	...	...	3,728 7 0	
Sanitary Commissioner, India	8	8	1,610	1,800	4,420	3,410	664 7 0	
Ditto ditto, Bengal	4	4	1,660	...	1,660	1,660	179 9 0	
Ditto ditto, Hyderabad Assigned Districts.	1	1	...	205	205	205	62 1 0	
Stationery Office, Calcutta	4	4	...	1,800	1,800	1,800	136 12 0	
Superintendent, Government Printing, India.	5	2	...	78	30	78	50 11 0	
Telegraph Department, India	76	26	...	27,849	16,887	27,849	1,649 14 0	
Traffic Superintendent, Eastern Bengal State Railway.	1	2	3,005	...	6,00	3,005	386 5 0	
Total	539	387	24,862	254,975	259,322	279,837	27,296 5 6	

LITHOGRAPHIC AND PRINTING OFFICE, CALCUTTA.

Statement showing Expenditure (Dr.) and Value of Work done (Cr.) during the year 1887-88.

DR. *CR.*

	R	a.	p.	R	a.	p.		R	a.	p.	R	a.	p.
Superintendent's salary	5,316	2	1				Standard and other maps and plans issued to the Survey of India Department	12,343	7	0			
Assistant Superintendent's salary	2,800	0	0				Miscellaneous maps issued to the Survey of India Department	1,074	15	0			
Establishment	34,235	9	9				Departmental Forms	9,305	11	0			
Office Rent and Taxes	3,893	10	0								22,724	1	0
Contingencies	1,343	9	0				Miscellaneous maps and plans, Extra-Departmental	27,296	5	6	27,296	5	6
Special Grant	203	7	7				Work done in Type Department	15,783	9	0	15,783	9	0
				47,792	6	5	Old tin and packing cases sent to Mathematical Instrument Office	36	5	0	36	5	0
Lithographic, drawing and printing materials received from England	1,619	0	0				Sale of waste paper, &c.	71	11	3	71	11	3
Type printing materials received from England	804	8	5				Miscellaneous articles supplied to other offices of the Survey of India Department	273	15	9	273	15	9
Paper received from England	6,338	10	4										
Patent Lithographic Plate Bed received from England	111	7	6										
Patent Lithographic Plates received from England	71	1	0										
Bending Machine for Patent Lithographic Plates received from England	55	3	9										
				8,999	15	0					66,185	15	6
Paper received from Stationery Office	13,373	11	8										
Miscellaneous articles received from Stationery Office	78	0	6										
				13,451	12	2							
Instruments received from Mathematical Instrument Office	2	3	0										
Cost of repair of articles at Mathematical Instrument Office	23	7	0										
				25	10	0							
Work done by other offices of the Survey of India Department	921	13	0	921	13	0							
Cloth received from the Photographic Office, Survey of India Department	23	10	0	23	10	0							
Paper received from the Engraving Office, Survey of India Department	695	0	0	695	0	0	Balance against the office	...			5,724	3	1
TOTAL	...			71,910	2	7	TOTAL	...			71,910	2	7

LITHOGRAPHIC AND PRINTING OFFICE, CALCUTTA.

Statement of Departmental work done during the year 1887-88.

Specification of Stone or Print.	Lithographic Printing.							Type Printing.		Total pulls.	Total copies.	Value.	Remarks.
	Progress made.	Scale of map.	Size of each sheet.	Sheets or subjects.	Stones.	Coloured copies.	Uncoloured copies.	Pages or items.	Pulls to each item.				
General Maps.												R a. p.	
Transferred from Copper-plate.		In. M.											
India, in 6 sheets, sheets Nos. 3 and 5	Additions & corrections made.	1 = 32	D. Elephant	2	2	...	...	...	...	...	...	436 15 0	Not yet printed.
India, in 6 sheets, sheet No. 2.	Ditto .	1 = 32	Ditto .	1	1	...	...	...	...	...	...	312 0 0	Do.
Reprints.													
Eastern Bengal, parts of Burma, Siam and China, in 4 sections.	...	1 = 32	Imperial .	4	8	...	100	...	...	800	100	78 1 0	
Canal map of India, in 6 sheets.	Additions & corrections made.	1 = 32	D. Elephant	6	11	100	...	...	...	1,100	100	446 9 0	
India, showing the progress of the Imperial Surveys to 1st October 1887, to accompany Annual Report.	Corrections, &c., made and colour stones prepared.	1 = 128	Imperial .	1	4	500	50	...	...	2,050	550	325 13 0	
India, showing district boundaries and names, in 2 sheets.	...	1 = 64	D. Elephant	2	2	...	50	...	...	100	50	28 14 0	
India, skeleton, in 2 sheets.	...	1 = 64	Ditto .	2	2	...	50	...	...	100	50	28 14 0	
Preliminary map of India, in 6 sheets.	...	1 = 32	Ditto .	6	6	...	50	...	...	300	50	101 1 0	
Provincial Maps.													
Drawn during the year.													
N.-W. P. Compilation, sheet No. 2.	Drawn on transfer paper.	1 = 16	D. Elephant	1	1	...	...	...	...	...	...	241 8 0	Not yet printed.
Reprints.													
N.-W. P. and Oudh.	Corrections, &c., made.	1 = 32	Imperial .	1	1	...	100	...	...	100	100	71 6 0	
Ditto in 4 sections	...	1 = 16	S. Royal .	4	8	...	100	...	...	800	100	70 8 0	
Bengal . . .	...	1 = 80	½ Foolscap.	1	1	...	200	...	...	200	200	15 0 0	
N.-W. P. and Oudh	Corrections, &c., made.	Ditto	Ditto	1	1	...	...	...	...	...	...	7 3 0	Not yet printed.
Divisional Map.													
Reprint.													
Sitapur Division .	...	1 = 4	Special .	1	1	...	25	...	...	25	25	19 11 0	
District Maps.													
Transferred from copper-plate.													
24-Pergunnahs .	Additions & corrections made.	1 = 4	Atlas .	1	1	...	150	...	...	150	150	131 2 0	
Gya . . .	Ditto .	1 = 4	D. Elephant	1	1	...	...	...	...	...	...	175 3 0	Not yet printed.
Hazaribagh . .	Ditto .	1 = 4	Antiquarian	1	1	...	...	...	...	...	...	333 0 0	Do.
Durbhunga . .	Ditto .	1 = 4	D. Royal .	1	1	...	...	...	...	...	...	205 12 0	Do.
Mozufferpore . .	Ditto .	1 = 4	Atlas .	1	1	...	...	...	...	...	...	269 11 0	Do.
Sarun . . .	Ditto .	1 = 4	Ditto .	1	1	...	...	...	...	...	...	199 8 0	Do.
Chanda . . .	Ditto .	1 = 4	Special .	1	1	...	...	...	...	...	...	414 9 0	Do.
Transferred previously but printed during the present year.													
Jubbulpore . .	Further corrections made.	1 = 4	Antiquarian	1	1	...	150	...	...	150	150	122 13 0	
Burdwan . .	Ditto .	1 = 4	Atlas .	1	1	...	150	...	...	150	150	60 5 0	
Nowgong . .	Ditto .	1 = 4	D. Royal .	1	1	...	150	...	...	150	150	78 7 0	
Moorshedabad .	Ditto .	1 = 4	Atlas .	1	1	...	150	...	...	150	150	177 11 0	
Carried over .				44	60	600	1,475	...	...	6,325	2,075	4,351 8 0	

LITHOGRAPHIC AND PRINTING OFFICE, CALCUTTA.

Statement of Departmental work—continued.

Specification of Stone or Print.	Lithographic Printing.							Type Printing.					Remarks.
	Progress made.	Scale of map.	Size of each sheet.	Sheets or subjects.	Stones.	Coloured copies.	Uncoloured copies.	Pages or items.	Pulls to each item.	Total pulls.	Total copies.	Value.	
		In. M.										R a. p.	
Brought forward .				44	60	600	1,475			6,325	2,075	4,351 8 0	
District Maps —contd.													
Reprints.													
Dacca . . .	...	1 = 4	Atlas .	1	1	...	50	...	...	50	50	8 9 0	
Sylhet . . .	...	1 = 4	Ditto .	1	1	...	50	...	...	50	50	9 4 0	
City and Cantonment Plans.													
Reprints.													
Cantonment of Rangoon.	...	16 = 1	Special .	1	1	...	50	...	...	50	50	32 15 0	
Calcutta . . .	...	3 = 1	S. Royal .	1	1	...	100	...	...	100	100	11 6 0	
Atlas Sheet.													
Transferred from copper-plate.													
Quarter-sheet 49 N. W.	Additions and corrections made.	1 = 4	¼ Atlas .	1	1	...	...	...	...	...	...	228 4 0	Not yet printed.
Standard Sheets.													
Drawn during the year.													
Oudh Revenue Survey, Sheet No. 114.	Drawn on transfer paper.	1 = 1	D. Royal .	1	1	...	...	...	...	...	...	481 12 0	Not yet printed.
Do., Sheet No. 115 .	Ditto .	1 = 1	Ditto .	1	1	...	...	...	...	...	...	465 0 0	Do.
Do., Sheet No. 147 .	Ditto .	1 = 1	Ditto .	1	1	...	...	...	...	...	...	767 6 0	Do.
Do., Sheet No. 148 .	Ditto .	1 = 1	Ditto .	1	1	...	...	...	...	...	...	843 0 0	Do.
Do., Sheet No. 149 .	Ditto .	1 = 1	Ditto .	1	1	...	...	...	...	...	...	843 0 0	Do.
Do., Sheet No. 160 .	Ditto .	1 = 1	Ditto .	1	1	...	...	...	...	...	...	460 12 0	Do.
Do., Sheet No. 161 .	Ditto .	1 = 1	Ditto .	1	1	...	...	...	...	...	...	742 3 0	Do.
Do., Sheet No. 162 .	Ditto .	1 = 1	Ditto .	1	1	...	...	...	...	...	...	502 12 0	Do.
Do., Sheet No. 172 .	Ditto .	1 = 1	Ditto .	1	1	...	...	...	...	...	...	284 6 0	Do.
Do., Sheet No. 173 .	Ditto .	1 = 1	Ditto .	1	1	...	...	...	...	...	...	469 3 0	Do.
Do., Sheet No. 174 .	Ditto .	1 = 1	Ditto .	1	1	...	...	...	...	...	...	251 6 0	Do.
Do., Sheet No. 175 .	Ditto .	1 = 1	Ditto .	1	1	...	...	...	...	...	...	111 0 0	Do.
Drawn previously but printed during the present year.													
Oudh Revenue Survey, Sheet No. 116.	Corrections made.	1 = 1	D. Royal .	1	1	...	200	...	...	200	200	490 7 0	
Do., Sheet No. 102.	Ditto .	1 = 1	Ditto .	1	1	...	200	...	...	200	200	333 6 0	
Do., Sheet No. 117 .	Ditto .	1 = 1	Ditto .	1	1	...	200	...	...	200	200	445 10 0	
Index Maps.													
Transferred from copper-plate.													
Index Chart to the Great Trigonometrical Survey of India.	...	1 = 96	Atlas .	1	1	...	510	...	...	510	510	76 12 0	
Carried over .				65	81	600	2,835	...	...	7,685	3,435	12,209 13 0	
Index to the Indian Atlas, showing the sheets that have been published up to October 1887.	Corrections made and color stone prepared.	1 = 256	Foolscap .	1	2	500	50	...	...	1,050	550	64 11 0	

LITHOGRAPHIC AND PRINTING OFFICE, CALCUTTA.

Statement of Departmental work—concluded.

Specification of Stone or Print.	Lithographic Printing.							Type Printing.		Total pulls.	Total copies.	Value.	Remarks.
	Progress made.	Scale of map.	Size of each sheet.	Sheets or subjects.	Stones.	Coloured copies.	Uncoloured copies.	Pages or items.	Pulls to each item.				
		In. M.										₹ a. p.	
Brought forward .	...	...	...	65	81	600	2,835	...	...	7,685	3,435	12,209 13 0	
Index Maps—*contd.*													
Transferred from copper-plate—contd.													
Index to the Indian Atlas, showing the state of the engraving up to 1st October 1887.	Ditto .	1 = 256	Ditto .	1	2	500	50	...	...	1,050	550	68 15 0	
Miscellaneous Maps, Plans, &c.	...	...	...	52	42	2,255	15,519	...	...	12,827	17,774	849 15 0	
	...	...	...	1	1	...	...	...	...	...	...	225 0 0	Not yet printed.
Departmental Forms.	...	...	...	57	53	...	108,245	...	...	110,620	108,245	9,305 11 0	
Total .	...	...	...	177	181	3,855	126,699	...	...	133,232	130,554	22,724 1 0	
Circular Orders .	...	...	...	...	...	...	...	41	5,700	...	4,450	217 1 0	
Memoranda, &c. .	...	...	...	...	...	...	...	637	180,188	...	160,528	2,619 11 0	
Forms, &c. . .	...	...	...	...	...	...	...	579	782,632	...	314,165	10,233 15 0	
Transfers and proofs from Letterpress.	...	...	...	...	...	...	...	4,106	18,137	...	18,137	2,646 14 0	
Rubber Stamps made for Survey Department.	...	...	...	...	...	...	...	12	9	...	9	66 0 0	
Total .	...	...	...	...	...	...	...	5,375	986,666	...	497,289	15,783 9 0	
Total Value .	...	...	...	...	...	...	...	...	...	...	...	38,507 10 0	

MATHEMATICAL INSTRUMENT OFFICE.

TABLE A.

Detail of issues to and receipts from Provinces and Departments during the financial year 1887-88.

Provinces and Departments.	RECEIPTS.	ISSUES.	DEBITS.	CREDITS.
	Value.	Value.	Value.	Value.
	₹	₹	₹	₹
Archæological Survey	0	85	85	...
Assam	6,213	5,952	...	261
Bengal, Civil	7,537	21,670	14,133	...
Bengal, Military	3,039	15,972	12,933	...
Bombay, Civil	200	746	546	...
Bombay, Military	152	3,586	3,434	...
Burma	1,354	28,345	26,991	...
Central India	0	169	169	...
Central Provinces	247	2,319	2,072	...
Foreign States, Colonial Government, Straits Settlements	0	2	2	...
Foreign States, Berar	0	285	285	...
Forests	2	2,622	2,620	...
Geological Survey and Museums	195	643	448	...
Guaranteed Railways, E. I. Railway	0	329	329	...
„ „ Rajputana-Malwa Railway	428	61	...	367
Hyderabad, P. W. Department	10	154	144	...
Madras, Civil	521	46	...	475
Madras, Military	1,154	5,657	4,503	...
Marine	70	319	249	...
Meteorological Department	141	786	645	...
Mint	163	0	...	163
N.-W. P. and Oudh	1,155	2,097	942	...
N.-W. State Railway, P. W. Department.	7,660	3,371	...	4,289
P. W. D., Military Works	555	10,422	9,867	...
P. W. D., Coorg	0	83	83	...
Post Office	0	5	5	...
Punjab	1,282	26,440	25,158	
Rajputana, P. W. D.	934	390	...	544
Sind, Pishin, Bolan State Railway	3,685	6,588	2,903	...
Survey Department	18,639	90,939	72,300	...
Telegraph	119	2,174	2,055	...
TOTALS	55,455	2,32,257	1,82,901	6,099
NET DEBIT	...	...	1,76,802	
Cash Sales	...	4,545	4,545	
GRAND TOTAL	55,455	2,36,802	1,81,347	

MATHEMATICAL INSTRUMENT OFFICE.

TABLE B.

Instruments, &c., purchased in the local market during the financial year 1887-88.

Instruments.	Number.	Value. ₹	a.
Alt-azimuth pocket Instruments, Casella's	6	720	0
Barometers, Aneroid, small	6	345	0
Bars, standard steel, 6′	2	150	0
Boards, drawing, deal, large	2	36	1
„ „ cavalry pattern	7	126	0
Camera lucida	2	80	0
Cases, sketching, leather	25	384	9
Chains, measuring, steel	4	58	0
Chronographs	1	42	8
Clinometers	15	445	9
Compasses, bow, electrum, spring	132	332	0
„ „ sets	2	18	0
„ drawing, common brass 5″	209	292	14
„ „ „ „ 6″	215	397	6
„ „ „ electrum 5″	41	72	4
„ „ „ „ 6″	49	90	8
Compasses, drawing, with pen and pencil	15	30	0
„ magnetic, for plane-tables 2½″	12	72	0
„ „ „ „ 5″ needles	24	336	0
„ „ „ „ 6″ „	8	136	13
„ „ pocket, in brass case	1	12	0
„ „ „ electrum case	20	383	0
„ Napier's	4	60	0
„ prismatic silver ring 3″	2	115	0
„ „ Hunter's pattern	8	260	0
Clinometer compasses, Watkin's	5	252	8
Compasses, surveying, English	1	25	0
Curves, railway circular, small set	2	120	0
Glasses, binocular, large	3	120	0
Hydrometers with brass floats	4	195	0
Hygrometers, Mason's	3	40	8
Instruments, drawing mathematical brass, 1st sort	7	487	0
„ „ „ „ 2nd „	2	77	8
„ „ „ „ 3rd „	1	19	0
„ „ „ electrum, 1st „	4	305	8
„ „ „ „ 2nd „	3	135	0
„ „ „ „ 3rd „	4	86	0
Lamps, bull's eye	3	12	0
Lenses, reading	4	9	0
Levels, dumpy, 12″	1	180	0
„ „ 14″	4	1,120	0
„ reflecting, Abney's	6	211	0
„ Y pattern	1	285	0
Machines, map printing, Ordnance pattern	18	765	0
Opiesometers	35	237	8
Pedometers	1	32	0
Pens, drawing, common ivory handles	64	125	0
„ „ double or road	2	10	0
„ tracer's, steel, ivory handles	18	19	11
Pins for maps, brass	2,808	212	0
„ „ „ electrum	979	67	3
Plane tables, deal	23	200	0
Prickers	2	3	0
Protractors, plane circular brass, 6″	1	20	4
„ „ „ electrum, 6″	1	28	0
„ with adjustment circular brass, 6″	1	56	0
„ „ „ „ electrum	1	68	0
„ rectangular ivory, 6″	34	121	12
Carried over	4,858	10,635	14

MATHEMATICAL INSTRUMENT OFFICE.

TABLE B—*continued.*

Instruments, &c., purchased in the local market—continued.

	Number.	Value.	
		₹	a.
Brought forward	4,858	10,635	14
Protractors rectangular ivory Aldershot	22	132	0
„ „ boxwood	11	38	8
„ „ wooden, 6″	20	29	3
„ Sandhurst's boxwood, Gale and Poldens	24	40	8
Pins for chains, common pattern	17,000	1,328	2
„ „ Revenue survey pattern	1,550	290	10
Rules, carpenter's boxwood, 2′ 4 fold	113	127	7
„ parallel bar, ivory, 6″	36	114	0
„ „ wooden, 6″	53	39	12
„ „ rollers, wooden	22	263	0
Rules, sight, for plane-tables	405	1,213	13
Scales, architects' boxwood, single	23	47	4
„ „ ivory, single	22	110	0
„ engineering, boxwood	10	7	8
Scales, horn	100	65	10
Sheets, horn	75	39	6
Scales, marquois sets, wooden	6	52	8
„ offsets, single, ivory	119	119	0
„ „ „ wooden	57	28	8
„ plotting sets, ivory	2	75	0
„ „ „ wooden	4	50	0
Slopes and batters, ebonite sets	9	31	8
Squares, optical	776	5,044	0
„ set, ebonite sets	6	42	0
„ „ „ single	72	84	0
Staves, levelling telescopic Sopwith's	2	32	0
Sun-dials	3	166	8
Stands for compasses	5	52	8
„ „ levels, dumpy	6	235	0
„ „ plane tables	533	3,762	0
Scales, plotting, single, ivory	120	672	0
„ „ „ wooden	79	151	10
Stands for theodolites, transit, 5″	8	320	0
T. squares, wooden, of sizes	3	15	5
Tapes, measuring, metallic, 50′	294	1,246	15
„ „ „ 66′	8	36	0
„ „ „ 100′	207	1,483	6
„ „ steel, pocket, and others	49	1,038	2
Telemeters	3	180	0
Telescopes with paneratic eye piece, terrestrial	2	113	2
Theodolites, Everest's, with vertical arc, 6″	2	820	0
„ without vertical circle, transit	6	2,460	0
Thermometers, common	12	24	0
„ spare for Syke's hydrometers	20	56	0
„ grass	2	22	0
TOTAL	26,759	32,935	9
Books.			
Frisk's Electricity	1	6	6
Howell's Slide Rule Companion	1	1	1
Lindsay's Screw-cutting Tables	1	1	4
Hints to Travellers	10	47	14
Hutchinson's Military Sketching	1	2	9
Nautical Almanacs	123	225	15
Carried over	137	285	1

MATHEMATICAL INSTRUMENT OFFICE.

TABLE B—*concluded.*

Instruments, &c., purchased in the local market—concluded.

	Number.	Value.
		₹ a. p.
Brought forward	137	285 1 0
Nelthropp on Watch Work	1	4 3 0
Napier's Electro-Metallurgy	1	4 13 0
Chemist's Pocket Book by Bailey	1	3 3 0
Tables for Barometrical Heights by Mackesy	6	12 0 0
„ Log., Chamber's	42	123 4 0
„ „ Hutton's	8	47 8 0
„ „ Shortrede's, with Sines and Tangents	12	230 5 0
„ Traverse, Boileau's	23	177 14 3
Woomell's Electricity in the Service of Man	1	12 12 0
Regulations for the use of Watkins' Range Finders	6	4 8 0
Lardner and Harding's Optics	1	3 3 0
TOTAL	239	908 10 3
Sundries.		
Glasses for pluviometers	22	88 0 0
Knives for instrument boxes	12	7 2 0
Numbers for chains, iron, sets	3,567	536 7 6
Pencil leads for instruments	9	13 12 0
Wheels for dotting pens	49	171 8 0
Cases, leather	66	243 0 0
Umbrellas, surveying	7	111 0 0
Glass ink bottles	72	9 6 0
Glass tracers	12	0 8 0
„ for thermometer, wet bulb	20	1 14 0
Bottles for rain gauges	10	2 8 0
Snap-headed wrought iron screws, ¾″ long	500	213 12 0
„ „ „ „ „ 12″ „	500	
Polishing pads for mirrors	2	8 13 9
TOTAL	4,848	1,407 11 3
BOOKS	239	908 10 3
INSTRUMENTS	26,759	32,935 9 0
GRAND TOTAL	31,846	35,251 14 6

TABLE C.

List of instruments, &c., manufactured in workshop during the financial year 1887-88.

	Number.	Value.
Instruments.		
		₹ a.
Bars, standard, steel	3	120 0
Boards, drawing, deal, large	70	920 0
„ „ „ small	53	301 15
Chains, measuring, 33′	150	750 0
„ „ 50′	3	18 0
„ „ 66′	975	8,287 8
„ „ steel	9	82 0
Carried over	1,263	10,479 7

MATHEMATICAL INSTRUMENT OFFICE.

TABLE C—*continued.*

List of instruments, &c., manufactured in workshop during the financial year 1887-88.
—continued.

	Number.	Value.	
		₹	a.
Brought forward	1,263	10,479	7
Chains, measuring iron, 100′	116	1,085	0
„ „ other sizes	19	118	4
Clinometers	7	24	8
„ with hill shading scale and plummets	73	94	8
„ survey pattern	39	1,125	0
„ paper scales, Colonel Macdonald's pattern	250	93	12
Combs, acre, calculating, card board	1,382	558	10
Compasses, magnetic, for plane tables, 5″ needles	48	630	0
„ „ „ „ 6″ „	36	516	0
„ surveying, Bengali	2	36	0
„ „ English	2	130	0
Curves, French, small sets	13	157	10
„ horn, for conic sections	3	6	0
Glasses, copying or tracing	6	246	4
Heliographs	6	828	0
Hold-alls	33	525	0
Lamps, bull's eye	18	102	0
„ referring	18	88	12
Levels, field service, 4″	9	225	0
„ spirit, in metal cases, 4″	6	42	0
„ „ „ „ 6″	6	45	0
„ „ „ „ 8″	6	60	0
„ „ „ „ 9″	9	90	0
„ „ „ „ 12″	6	75	0
„ „ wooden „ 9″	2	11	0
„ water	36	92	14
Plane tables, deal	604	5,243	8
„ „ „ military	25	99	8
Pluviometers, Symon's	50	525	0
Pins for chains, common pattern	740	75	10
Rods, measuring, wooden	136	320	0
Rules, flat, ebonite, 2″	78	29	4
„ „ „ 1′	207	155	4
„ parallel on rollers, brass, 6″	3	22	8
„ sight for plane tables	17	292	8
„ „ brass for military plane tables	26	280	0
Scales, diagonal, card board	6,301	1,502	10
„ „ metal	59	340	0
„ engine-divided, card board, single	3,101	728	4
„ offsets, single, ivory	418	247	4
„ plotting sets, ebonite	3	54	0
„ „ „ ivory	18	720	0
Staves, cross or offsets	6	30	0
„ levelling, Roorkee pattern, double	12	288	0
„ „ G. T. survey pattern	2	32	0
„ „ telescopic	82	1,262	0
Stands for compasses, Bengali (English make)	2	9	0
„ „ „ English	2	32	0
„ „ Heliographs	6	72	0
„ „ plane tables	25	407	0
„ „ theodolites	4	130	0
T. square, metal	1	10	0
TOTAL	15,342	30,392	13

MATHEMATICAL INSTRUMENT OFFICE.

TABLE C—*concluded.*

List of instruments, &c., manufactured in workshop, &c.—concluded.

	Number.	Value.
		₹ a.
Sundries.		
Boxes and cases, block tin	2	49 3
Cases, packing	796	1,782 1
Doolies	13	22 12
Gauges, writing	6	10 8
Tubes, tin and zinc, &c.	97	57 7
Plummets	18	28 0
Stencil plates	28	53 8
Canvas bags, water-proof, lined	70	356 12
Line dividers, electrum	2	64 0
Bar for beam compass	1	5 4
Numbers for chains	1,000	87 4
Handles, brass, for ditto	50	
Rings for chains	400	3 12
Staves for omnimeter or subtense theodolite, 10′	10	250 0
Centre screws for plane tables	20	30 0
Bolts for plane table stands	27	40 8
Handles, brass, for chains	20	15 0
Scales, electrum, for compasses	2	20 0
Canvas covers for theodolite boxes	2	16 0
Shoulder straps	4	
Curves, horn	3	1 8
Adjustable keys for compasses	24	9 8
Speedometer, attachment	1	16 0
Scale, ivory	1	2 8
Ornamental alphabet	1	3 12
„ „ figure	1	1 8
TOTAL	2,618	2,926 11
Add—Total of Instruments	15,342	30,392 13
SUM TOTAL	17,960	33,319 8
Brass Castings, &c., for Material Stock	...	1,728 0
GRAND TOTAL	...	35,047 8

TABLE D.

List of principal instruments repaired in workshop during the financial year 1887-88.

	Number.
Anemometers	17
Anemograph	1
Arithmometers	4
Barometers of sorts	64
Callipers	1
Camera	1
Chains of sorts	62
Chronograph	1
Chronometers	20
Clinometers	2
Clocks	9
Compasses, beam	3
„ boat	3
„ bow pen	41
„ „ pencil	1
„ „ spring divider	4
„ drawing, of sorts	96

MATHEMATICAL INSTRUMENT OFFICE.

TABLE D—*continued.*

List of principal instruments repaired in workshop, &c.—continued.

	Number.
Compasses, magnetic for plane tables, &c.	16
„ „ pocket	27
„ mining	2
„ pen and pencil legs, in cases	3
„ prismatic, of sorts	81
„ proportional	3
„ rectangular, for theodolites	17
„ surveying, of sorts	21
„ tell-tale	1
Glasses, binocular	15
Hand presses	4
Heliographs	18
Hydrometers	41
Hygrometers	4
Instruments, drawing, mathematical, of sorts	29
Instruments for measuring facial angles	1
Lenses of sorts	2
Levels of sorts	119
„ spirit	35
Log, patent	1
Meters, current	2
Micrometers	2
Microscopes	2
Mirrors of sorts	2
Pens, drawing, of sorts	90
„ double or road	3
Pentagraphs	2
Perambulator	1
Plane tables	10
Planimeters	6
Pluviometers	43
Pointer, station	1
Pins for chains	10
Protractors, of sorts	9
Quadrant, Gunner's	3
Range finders	35
Rules, of sorts	44
„ sight, for plane tables	9
Scales, of sorts	37
Sextants, of sorts	11
Squares, co-ordinate	1
„ optical	73
Stands for compasses, of sorts	40
„ „ heliographs	16
„ „ levels	52
„ „ plane tables	18
„ „ theodolites	38
Staves, of sorts	92
Sun-dial	1
Sympiesometer	1
T. squares	1
Tapes, of sorts	12
Telescopes, of sorts	40
Theodolites, of sorts	89
Thermometers, of sorts	33
Type-holders	2
„ handpress	1
Watches, of sorts	21
Wheel	1
TOTAL OF PRINCIPAL INSTRUMENTS REPAIRED	1,724
MINOR INSTRUMENTS REPAIRED	1,288
TOTAL OF ALL INSTRUMENTS REPAIRED	3,012

Profit and Loss Account of the workshop for the financial year 1887-88.

Debits.	₹	a.	Credits.	₹	a.
Workshop establishment, less proportion debitable to the store branch for cleaning and adjusting serviceable instruments . . .	35,092	10	By repairs for public officers .	12,706	0
One-third of office establishment	2,315	0	,, to stock . .	25,042	1½
Pay of Material Store-keeper for the whole year . .	710	0	,, manufactures for stock —		
Workshop contingencies as distinguished from materials purchased . . .	2,608	7	,, Intruments . . .	31,528	8
Value of materials —			,, Packing cases . .	1,791	0
For special work . .	18,796	5			
,, general workshop use .	478	8	,, manufactures for materials .	1,731	8
,, manufacture of packing cases . . .	1,074	9			
Paid for repairs . . .	25	0	Work done for workshop, store and correspondence branches of office . . .	396	3
Wear and tear of plant .	1,819	8			
Half of rent at ₹325 per mensem	1,950	0			
Printing and stationery .	401	13	Work on pre-payment . .	910	15
Four per cent. on value of tools and plant amounting to ₹62,200 . . .	2,488	0			
Workshop profit . . .	6,346	7½			
Total .	74,106	3½	Total .	74,106	3½

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Extract from the Narrative Report of Lieutenant S. G. Burrard, R.E., *in charge Computing Party, season 1887-88.*

Up to April 9th, Mr. Cole and Major Rogers had charge of the six sections of this party, *viz.*, Computing, Photo-zincographic, Drawing, Type-printing, Stores, and Solar Photographic, with Mr. Eccles and Lieutenant Burrard as their Assistants. Thereafter Colonel Holdich took charge of the Drawing Section and Lieutenant Burrard of the Computing, Photo-zincographic, Type-printing, Stores and Solar Photographic Sections, and there was no Assistant Officer of the Senior Division.

The following tabular statements exhibit the money value of the work performed by the Computing Section during the survey year 1887-88 :—

Statement of Expenditure (Dr.) and amounts credited (Cr.)

Dr.	₹	₹	Cr.	₹	₹
Deputy Superintendent's salary .	9,647		Departmental work as shown in the following table . .	44,367	
Establishment	33,357				44,367
Contingencies and travelling allowances	807	43,811			
Stationery	50	50	Extra-departmental work done	240	
Library, books and periodicals, also for binding of auxiliary tables	746	746			240
Total .	...	44,607	Total .	...	44,607

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Statement of Departmental Work.

Class.	Value.
	₹
Records, Library (including cost of purchase of books, &c., and binding of auxiliary tables)	2,298
Computations	14,665
Accounts, returns, correspondence	1,579
Supply of data, &c.	1,198
Preparation of press copies	8,650
Examination of press proofs	3,475
Ditto charts, &c.	447
Protection of stations	1,149
Miscellaneous	9,740
Meteorology and general science	1,166
TOTAL	44,367

Statement showing the value of work done for other Departments.

Departments.	Value.
	₹
Meteorological Department	240
TOTAL	240

Some explanations of the various items will now be given.

CLASS 1. RECORDS, LIBRARY, &C.—The records of all the survey operations appertaining to the Trigonometrical Branch, from the time of Colonel Lambton to the present date, find a resting-place in this office, where they are carefully stored and periodically inspected. As each instalment is received, it is closely examined as to completeness in all required details, indexed, registered, and a detail receipt furnished to the Executive Officer from whom it comes; where incompleteness is observable, executive officers are at once called on to supply the detals wanting. The custody of the Library, which now contains over four thousand volumes and pamphlets of a scientific character, also comes under this head, as well as the cost of books and periodicals purchased during the year, both for the Library itself and also for the several Survey Parties of the Trigonometrical Branch. During the past year, moreover, the books of the Library have been systematically classified and arranged by shelves: every volume has been numbered and labelled, and the compilation of the Library Catalogue has been completed, and the greater portion passed through the press. With the rules now in force, for the issue and return of books, &c., it is practically impossible for any volumes to go astray.

CLASS 2. COMPUTATIONS.—The principal operations under this heading have been—

(a) *South-West Quadrilateral.*—The reduction of astronomical azimuths observed at five stations was finished: the heights of stations on the Kattywar Meridional Series were advanced.

(b) *North-East Quadrilateral.*—Some progress has been made with the reduction of the secondary triangulation of the Assam Longitudinal Series and Assam Valley Series. Owing to the contemplated extension of the principal triangulation into Upper Burma, it has very recently been decided to dissever the Assam Valley Triangulation from the North-East Quadrilateral, of which it merely formed a pendant, and to include it for simultaneous reduction with all the principal triangulation east of 92°, so as to harmonise it with the whole of the triangulation of Burma. This will necessarily involve the recasting of the computations to a large extent, and this will cause further unavoidable delay in the completion of the volume. One other series of this quadrilateral remains; but as the field work is not yet complete, it cannot be taken in hand at present.

(c) *Southern Trigon.*—Colonel Lambton's triangulation has been under treatment in order to reduce it to final terms; it forms a very extensive net-work, and though good progress has been made with it, a great deal yet remains to be done. The computations of the modern astronomical azimuths observed in the Trigon were finished; the heights of the South-East Coast Series have also been finished, and progress made with those of the Bombay Longitudinal and Mangalore Meridional Series.

(d) *Principal Triangulation East of 92°.*—Certain preliminary computations required for the reduction of the principal triangulation of the Eastern Frontier Series south of latitude 23° were commenced, and carried down as far as Prome.

(*e*) The following assistance was rendered to field parties to aid in bringing up their computations:—3 computers for 1½ months to the Astronomical Parties for reduction of longitude observations, 1887-88; 1 computer for 3 months to assist Major Gore in the

computation of the Afghan Boundary Commission work; 2 computers for 2 months to Coast Party, for reduction of past season's triangulation.

(*f*) Several tables of the new edition of Auxiliary Tables were extended at the request of the Quarter Master General of India from parallel 40° to 56°.

The remaining work performed under this class was of a miscellaneous character.

CLASS 3. ACCOUNTS, RETURNS AND CORRESPONDENCE.—Under this heading are included indents, estimates, monthly detailed and abstract progress reports, stock returns of Ordnance stores, the compilation of data for the Annual Report, and various other items. The assistance rendered in the current work of the Deputy Surveyor-General's office is also included in this class.

CLASS 4. SUPPLY.—Requisitions from forty-four officers for data of various kinds have been complied with. In this class is also included the cost of labour in the despatch of maps, charts, books and forms.

CLASS 5. PREPARATION OF PRESS COPY.—This consists in the writing of the letterpress for the several publications; and also in abstracting and compiling the results of the several calculations in a suitable form for publication. All tabular data, when so compiled, are carefully compared twice before handing to the printer. The details of the work are as follows:—

(a) *Southern Trigon.*—The appendix descriptive of Colonel Lambton's labours was revised and finally completed. The introduction to South Konkan Coast Series was written and passed through the press, and that of the Great Arc was revised and finished, thus completing the introductions to all the series of the Southern Trigon, which are now finally printed. The descriptions of the stations on the Bombay Longitudinal and Madras Meridional and Coast Series were compiled, revised and completed, and those of the South Konkan Coast Series were taken in hand. The sides and angles of all the circuit triangles, the synopses of latitudes, longitudes and azimuths of the traverse stations, and several other tables containing details of the simultaneous reduction have been re-compared and are now ready for the press. The abstract of heights of the South-East Coast Series was taken in hand and completed, and that of the Bombay Longitudinal Series partially done. All the above appertain to the forthcoming Professional Volume of the Southern Trigon, Part II of which is now practically ready. In the Synoptical Volumes of this section of the triangulation, the compilation of one, the South Konkan Coast Series, was completed, and that of the remaining six was commenced; the latter seems likely to prove a very lengthy and tedious job, owing to the numerous stations of Colonel Lambton's network that have to be incorporated. With the exception of the South Konkan Coast Series, no Synoptical Volume is likely to be finished for some years.

(b) *South-West Quadrilateral.*—The introductions to the six series were taken in hand. The sides and angles of circuit triangles, synopses of latitudes, longitudes and azimuths of traverse stations, and several other tables containing numerical details of the simultaneous reduction, have been compiled and compared. The revised descriptions of stations of the Khanpisura Meridional Series were compiled and passed through the press; abstracts of heights of the Guzerat Longitudinal, Abu Meridional, Singi Meridional, Kattywar Meridional and Cutch Coast Series, have been tabulated and compared. The numerical data for the Professional Volume of the South-West Quadrilateral are well advanced and practically only now require re-comparison before being ready for press. The Synoptical Volumes of this section of the triangulation have as yet not been touched.

(c) *North-East Quadrilateral.*—The compilation and comparison of the table of azimuths for 18 degree sheets, appertaining to the forthcoming Synoptical Volume, No. XXII, Assam Longitudinal Series, were finished.

(d) *Afghan Boundary Commission Triangulation.*—The Preliminary Synoptical Volume containing the survey operations with the Afghan Boundary Commission has been compiled, compared and passed through the press; it has been numbered Synoptical Volume $\frac{1}{B}$, and only awaits the charts to be put into the hands of the binder. The appendices were written by Colonel Holdich and Major Gore.

(e) *Principal Triangulation East of 92°.*—The details of the reduction of figures on the Eastern Frontier Series, below parallel 23° as far south as Prome, were tabulated, but have not yet been compared.

(f) *Observed Latitudes.*—Great progress has been made in the printing of the new Professional Volume, that contains the details of the astronomical latitudes observed in India prior to 1885; four hundred pages have been compared, passed and printed off. This Volume, which promises to surpass all its predecessors in bulk, will be ready for issue in the summer of 1890.

(g) *Electro-Telegraphic Longitude Operations.*—A new Professional Volume, which when completed will make the third devoted to longitude work, has been started; the printing of the numerical details of the ten arcs measured over the North-West Quadrilateral in the season 1885-86 has been put in hand.

(h) *Spirit-levelling Operations.*—The pamphlet of heights, No. 2, Madras Presidency, was published and issued; and No. 3, Madras Presidency, was commenced, passed through the press, and also issued during the year.

(i) *Library Catalogue.*—The compilation of a catalogue of the books in the Library was finished, and the printing all but completed.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

CLASS 6. PRESS PROOFS.—The work done under this heading relates entirely to the Printing Section. It consists of the examination and comparison of proofs. As most of the matter printed is numerical, or depends on numerical data, this examination can only be performed by men thoroughly acquainted with all the details of the subject in hand. Ordinary press readers could not be expected to render the critical examination which such matter requires. The charge for this class, though shewn against the Computing Section in order to balance the cost, is debited against the Printing Section. Should the cost of the two sections be combined, this sum (₹3,475) should be deducted from the total.

CLASS 7. CHARTS.—The careful examination of all charts of triangulation and of spirit-levelled heights before publication is a matter of much importance, and this work is also performed by the Computing Section, where the familiarity with the original records renders the detection of mistakes much easier and more certain than if the examination was made by the draftsmen themselves. All the charts, diagrams, &c., prepared during the year by the Drawing Section for the publications of the office were so examined; among them may be specially noted twelve triangulation charts of the Afghan Boundary Commission Survey, two coast triangulation charts, and one chart of spirit-levelled heights for pamphlet No. 3, Madras Presidency. Several index charts referring to the principal and secondary triangulation and to sheets of levels, have been examined: these are intended for the new map catalogue under compilation at the Calcutta Office.

CLASS 8. STATIONS.—The necessary professional aid in connection with the protection of survey stations has been rendered by the Computing Section to the office of the Deputy Surveyor-General. During the year under review seven hundred and ninety-three stations have been repaired by District Officers at a cost of ₹2,840; thirty-eight districts out of the three hundred and twenty-eight from which reports are due, failed to submit them.

CLASS 9. MISCELLANEOUS.—In this class are included several duties of the Computing Section, which cannot fairly be assigned to any of the other classes, such as the following: (*a*) The current observatory work at Dehra, the rating of the chronometers, the cleaning and keeping in order of instruments of the larger class, &c., (*b*) the taking and reducing of time observations at Mussooree in order to give the time for the 12 o'clock gun; (*c*) the examination and systematic storing of the Trans-Frontier Instrumental Equipment; the testing and determination of the index errors both at Dehra and Mussooree of fifteen aneroid barometers, twenty-seven boiling point thermometers, and eighteen air thermometers; besides the determination of the values of micrometer and level scales of several subtense theodolites; (*d*) the preparation or revision of fifteen professional forms; (*e*) the preparation of a list of all important places in India, Afghanistan, Tibet and Burma, with their co-ordinates, which was carried out for the French Government at the request of General Strachey, R.E.; (*f*) the astronomical experiments with the two Russian transit instruments; (*g*) the reduction of astronomical observations taken by an officer travelling in Persia; (*h*) the examination of mathematical formulæ that had been used in the Adjutant General's Department for computing an elevation gauge for Martini-Henry rifles; (*i*) assistance rendered to the Deputy Surveyor-General on a variety of professional points, chiefly the following:—

The preparation of a *resumé* of survey operations of the Trigonometrical Branch during Lord Dufferin's viceroyalty;

The adoption of a standard yard for India;

The discussion of conclusions arrived at from the Longitude work hitherto executed (embodied in Preface to Vol. X);

The preparation of the memo. for the guidance of trans-frontier explorers, and the forms to be used by them;

The examination of and correction for printing of the annual reports of Executive Officers for 1886-87;

(*j*) the detailed rearrangement, cleaning and labelling of all instruments, large and small, and all stores, which has been taken in hand and carried out this year.

CLASS 10. METEOROLOGY AND GENERAL SCIENCE.—

Meteorological observations.—A complete set of meteorological observations was taken daily throughout the year at Dehra Dun and monthly abstracts prepared.

Explorations.—A portion of Mr. Wood's time during the past year has been given up to the subject of Trans-Himalayan explorations; the reports on the travels of K. P. and Lama Serap Gyatsho in Tibet have lately been overhauled and revised by him.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Mean Monthly Readings of Earth Thermometers.

Depth in feet of thermometer bulbs below surface of ground.	Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
		°	°	°	°	°	°	°	°	°	°	°	°
25·6	1881	...	...	...	...	...	73·55	73·90	75·02	76·07	76·69	76·98	76·71 *
	1882	75·91	75·13	74·52	74·11	73·97	74·05	74·31	74·95	75·69	76·14	76·39	76·37
	1883	75·85	75·02	74·28	73·89	73·97	73·96	74·32	74·90	75·66	76·16	76·28	76·12
	1884	75·20	74·39	73·90	73·64	73·65	73·95	74·34	76·00	76·87	77·33	†77·27	76·72
	1885	75·83	74·95	74·34	74·00	73·92	74·02	74·25	‡	‡	‡	‡	‡
	1886	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡
	1887	(a) 74·58	74·67	74·30	73·80	73·50	73·55	73·95	75·05	76·01	76·20	76·28	76·20
	1888	75·90	75·49	74·87	74·22	73·87	73·83	74·10	(h)75·26	76·44	...	...	...
12·8	1881	...	...	...	...	...	74·87	76·47	77·88	78·98	79·26	77·71	74·89
	1882	72·33	70·79	70·47	71·70	73·37	75·23	76·87	78·20	78·98	79·02	77·64	74·89
	1883	72·46	70·36	69·83	70·94	73·00	75·17	76·82	78·20	78·97	78·93	76·93	73·50
	1884	70·95	69·75	70·04	71·47	73·39	75·75	77·42	79·24	79·82	79·34	§ 77·08	74·52
	1885	72·18	70·37	70·03	71·14	72·66	73·99	76·09	78·98	79·42	79·25	77·93	75·36
	1886	72·49	b 70·56	70·26	70·95	72·46	74·12	76·18	78·63	79·54	79·41	77·82	75·16
	1887 Old	(c) 72·56	68·80	69·67	71·12	73·38	76·09	77·65	79·23	79·77	79·30	77·08	74·10
	1887 New.	(d) 69·22											
		72·16	70·87	70·18	70·97	72·87	75·37	77·20	78·94	79·58	79·25	78·27	76·50
	1888	74·25	72·12	70·73	71·25	73·05	75·18	77·27	79·23	80·13	...	...	...
6·4	1881	...	...	...	...	...	80·66	81·01	80·75	81·24	80·33	75·80	70·58
	1882	67·17	66·06	67·75	72·29	76·47	80·01	80·78	81·30	81·32	80·16	75·75	71·03
	1883	67·64	65·10	66·48	71·00	76·72	79·29	80·70	81·42	81·12	79·50	74·50	68·71
	1884	66·03	65·61	67·95	72·36	76·99	80·76	81·46	81·64	81·10	78·85	73·81	69·57
	1885	66·64	64·83	66·73	71·10	74·29	77·59	80·32	80·77	80·85	79·90	76·19	70·97
	1886	66·53	64·72	66·61	69·99	74·87	77·87	80·34	81·54	81·70	79·92	75·50	70·69
	1887 Old¶	65·79	64·16	67·63	71·40	76·96	80·23	80·57	81·08	80·89	79·43	75·33	71·10
	1887 New	(e)64·65	64·54	67·58	71·72	77·91	80·94	80·86	81·11	80·88	79·58	75·94	71·97
	1888	67·67	64·78	67·04	71·91	76·84	80·67	82·14	81·79	81·50	...	...	...
3·2	1881	...	...	...	...	...	85·93	83·29	82·03	82·40	79·67	72·20	65·59
	1882	62·57	62·31	67·61	75·49	80·86	84·77	82·71	83·04	82·20	79·21	71·73	66·14
	1883	62·27	60·70	64·83	74·13	81·57	83·44	83·00	83·48	81·74	78·23	69·72	62·50
	1884	61·23	61·90	67·69	75·75	82·32	85·11	84·20	81·94	81·38	76·50	69·32	64·18
	1885	61·38	60·28	65·97	73·52	76·30	82·30	82·68	80·94	81·35	78·73	72·55	65·37
	1886	60·79	60·22	65·33	72·39	78·89	82·14	82·55	82·48	82·37	78·44	71·74	65·56
	1887	(f)61·70	59·99	68·80	76·55	85·47	84·93	82·56	81·63	81·31	78·23	72·08	66·91
		58·57											
	1888	61·77	60·46	67·93	76·58	82·31	86·18	83·84	82·53	81·14	...	...	...
1·1	1881	...	...	...	...	...	89·16	84·14	82·55	83·19	77·81	67·81	60·72
	1882	58·91	59·41	69·50	78·88	84·99	88·24	83·48	84·08	82·89	77·85	67·96	62·17
	1883	57·98	58·45	65·87	79·53	86·65	87·94	84·55	84·89	82·19	76·70	65·41	57·83
	1884	58·28	59·89	69·56	80·14	88·27	88·57	85·59	82·03	81·64	74·14	65·38	60·10
	1885	57·35	57·75	68·28	77·20	78·63	87·22	84·35	81·16	82·09	77·45	69·03	60·91
	1886	57·13	57·76	66·25	77·19	83·02	86·44	83·78	82·99	83·16	76·78	68·36	61·20
	1887	55·80	58·16	69·27	79·12	89·25	85·94	82·73	81·34	81·01	75·79	67·54	61·31
	1888	55·79	57·31	{g67·20 / 71·80}	79·87	85·75	89·71	83·34	82·81	80·38	...	...	...
Thermometer in shade.	1881	...	...	...	...	...	87·68	82·54	81·00	82·86	82·72	75·22	71·19
	1882	66·77	66·51	81·36	88·72	91·04	89·11	81·61	82·40	84·62	83·47	75·04	72·36
	1883	64·80	68·72	75·89	91·83	95·54	90·60	83·54	83·85	82·86	82·00	70·95	66·12
	1884	67·36	68·52	81·32	89·51	97·33	89·69	83·86	79·73	80·30	77·30	71·77	67·37
	1885	62·50	65·44	79·35	85·63	84·47	91·97	82·74	79·08	82·41	81·98	75·09	66·31
	1886	63·04	67·49	73·74	88·55	87·82	90·60	82·35	81·75	85·05	80·90	74·56	68·93
	1887	59·79	70·64	80·37	89·88	98·66	89·09	81·28	78·60	83·34	80·03	74·73	67·50
	1888	62·74	66·99	81·89	91·99	95·80	96·33	82·21	80·27	81·74	...	...	...

* The hole, which had gradually filled up about 2½ feet, was dug down to the original depth between the 20th and 24th December 1881.

† The hole, which had gradually filled up 2 feet since December 1881, was dug down to the original depth between the 9th and 18th November 1884.

‡ Earth fell in from the sides of the hole on the 2nd and 3rd August 1885, and covered the thermometer to the depth of 11 feet. It was found impossible to sink another thermometer to this depth till 20th January 1887, when a new hole was dug down to the depth of 25·6 feet and lined with 4-inch stoneware pipes.

(*a*) This is the mean of the readings of the last eleven days of the month.

§ The hole, which had gradually filled up 11 inches since June 1881, was dug down to the original depth on the 17th and 18th November 1884.

(*b*) When the 25-foot hole filled up in August 1885, the 12-foot hole, which was close by, deepened about a foot, and the length of chain being greater than necessary, the thermometer remained suspended at a depth of 14 feet till 23rd January 1887, when the hole was filled up till it was only 12·8 feet deep. At the same time a new hole was dug to this depth and lined with 4-inch stoneware pipes. Readings from both have been regularly taken for the sake of comparison.

(*c*) This is the mean of the readings of a 14 feet deep thermometer for the first twenty-three days of the month.

(*d*) This is the mean of the readings of a 12·8 feet deep thermometer on the last seven days of the month.

¶ A new hole was dug in January 1887 and lined with stoneware pipes, but the old hole was left undisturbed for the sake of comparing the readings.

(*e*) This is the mean of the readings of the last seven days of the month.

(*f*) This is the mean of the readings of the first thirteen days of the month, after which a new hole was sunk lined with 4-inch stoneware piping, and the reading below is for the last fourteen days of the month.

(*g*) This is the mean of the readings of the first twenty days of the month, after which a new hole was sunk lined with 4-inch stoneware piping, and the reading below is for the last eleven days of the month.

(*h*) Mean of twenty-five days of the month, the instrument being out of order from 11th to 16th August.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Mean velocity in Miles of the Winds which blew at Dehra Dun during the twelve months of 1887-88, for each hour of the day.

Civil Hours.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
0 to 1	2·07	1·41	0·75	0·77	1·34	1·97	1·20	1·17	1·20	0·61	0·29	1·20
1 „ 2	1·70	1·41	1·17	0·68	1·14	1·94	1·07	0·86	1·20	0·45	0·75	1·10
2 „ 3	1·63	0·79	0·71	0·58	0·97	1·71	1·00	1·10	1·30	0·42	0·46	0·97
3 „ 4	1·30	0·76	0·58	0·61	1·03	1·68	0·80	0·86	1·03	0·52	0·32	0·60
4 „ 5	1·22	0·52	0·33	0·42	0·90	1·35	0·93	0·76	0·77	0·68	0·18	0·83
5 „ 6	1·15	0·52	0·25	0·35	1·21	1·00	0·83	0·83	1·07	1·03	0·14	0·53
6 „ 7	1·04	0·21	0·25	0·35	1·00	0·90	0·73	0·86	0·90	0·68	0·50	0·73
7 „ 8	0·56	0·21	0·29	0·35	0·72	0·81	0·59	0·76	1·57	0·61	0·71	0·47
8 „ 9	0·67	0·34	0·33	0·42	1·14	0·71	1·00	1·28	1·73	0·52	1·00	0·80
9 „ 10	1·15	0·90	0·46	0·61	1·41	1·58	1·97	1·90	2·13	0·65	1·50	1·57
10 „ 11	1·43	1·00	1·08	0·84	1·83	2·19	2·62	2·52	2·97	1·16	1·79	1·87
11 „ 12	2·29	1·55	1·46	1·19	2·24	2·29	3·11	3·28	3·73	1·45	2·10	1·53
12 „ 13	2·70	1·93	1·75	1·48	2·66	3·13	3·83	3·52	3·73	1·32	1·85	1·60
13 „ 14	2·48	2·14	1·67	1·39	2·97	3·13	3·33	3·97	3·87	1·61	2·11	2·10
14 „ 15	2·48	2·21	1·42	1·68	3·83	3·55	4·30	4·41	4·27	1·35	1·78	2·37
15 „ 16	2·37	1·61	1·29	1·65	4·00	2·71	4·47	4·14	5·03	1·10	1·61	2·20
16 „ 17	1·11	0·59	0·54	1·26	3·79	2·87	3·97	4·52	5·03	1·06	1·00	2·10
17 „ 18	0·07	0·31	0·13	0·68	1·76	1·58	3·50	3·97	4·27	0·87	0·93	1·13
18 „ 19	1·30	0·97	0·21	0·29	0·52	0·42	1·63	2·31	2·23	0·35	0·46	0·60
19 „ 20	1·81	1·62	0·33	0·35	0·38	1·16	0·93	1·34	1·20	0·19	0·32	0·73
20 „ 21	2·07	2·17	0·67	0·32	0·62	1·74	1·13	1·07	0·67	0·26	0·50	0·90
21 „ 22	2·41	2·21	1·17	0·65	1·07	2·35	1·60	1·48	1·53	0·32	0·39	1·10
22 „ 23	2·67	2·14	1·08	0·68	1·17	2·03	1·47	1·52	1·53	0·39	0·43	1·07
23 „ 24	2·59	1·69	1·13	0·71	1·17	1·97	1·20	1·17	1·03	0·68	0·14	1·20
Sums	40·27	29·21	19·05	18·31	38·87	44·77	47·21	49·60	53·99	18·28	21·26	29·30
Average	1·68	1·22	0·79	0·76	1·62	1·87	1·97	2·07	2·25	0·76	0·89	1·22

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Monthly Meteorological Results taken from the Register

Year and Month.	Barometer reduced to 32° Fahrenheit.						Hygrometer.			
	At 9-30 A.M.			At 3-30 P.M.			At 9-30 A.M.		At 3-30 P.M.	
	Highest.	Lowest.	Monthly mean.	Highest.	Lowest.	Monthly mean.	Monthly mean temperature of dew point.	Monthly mean humidity.	Monthly mean temperature of dew point.	Monthly mean humidity.
1887.										
October	27·814	27·613	27·719	27·719	27·529	27·630	58·6	·656	58·8	·536
November	·911	·753	·823	·825	·659	·740	49·9	·651	51·3	·485
December	·907	·723	·840	·812	·653	·747	43·0	·641	43·6	·457
1888.										
January	·974	·671	·820	·876	·620	·741	40·9	·720	42·1	·534
February	·908	·641	·771	·818	·577	·701	45·9	·704	45·2	·497
March	·798	·520	·684	·722	·489	·612	50·0	·469	46·6	·317
April	·675	·404	·555	·601	·340	·475	46·7	·301	42·3	·204
May	·666	·351	·506	·596	·296	·424	50·8	·319	47·0	·220
June	·504	·272	·381	·409	·183	·301	58·0	·428	53·4	·282
July	·477	·266	·387	·447	·185	·321	73·5	·882	74·6	·807
August	·540	·320	·428	·442	·253	·364	73·2	·837	74·2	·832
September	·660	·490	·582	·602	·410	·512	70·2	·797	71·6	·748

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

at the Trigonometrical Branch Office, Dehra Dun.

THERMOMETER.								RAIN.		WIND.	CLOUD.	
DRY BULB.					WET BULB.							
Maximum in sun's rays.	Minimum on grass.	Maximum in air.	Minimum in air.	Monthly mean in air.	Maximum in wet.	Minimum in wet.	Monthly mean in wet.	Number of days it fell.	Fall in inches.	Most frequent direction.	At 9-30 A.M.	At 3-30 P.M.
144·2	46·4	85·2	51·7	70·3	77·5	49·8	64·3	3	0·62	N.N.E.	1	2
133·3	40·4	76·8	47·0	63·0	66·3	44·7	56·1	0	0	Calm	1	1
127·0	30·8	72·9	37·6	57·1	63·3	36·5	50·8	1	0·04	Calm	1	2
126·7	29·8	69·4	34·7	52·5	58·4	34·7	47·3	7	4·74	Calm	4	5
132·5	34·4	79·2	40·6	57·2	65·5	39·0	51·6	7	0·94	Calm	4	6
146·9	45·6	90·7	53·2	70·3	71·7	47·5	59·6	4	0·32	N.N.E.	3	3
153·5	44·4	99·7	53·2	78·9	75·0	44·6	61·8	3	0·02	Calm	2	3
155·5	53·5	104·0	61·0	83·5	78·7	48·8	65·5	5	1·23	Calm	1	1
161·0	61·3	106·7	64·7	85·8	80·7	56·5	69·9	8	2·10	W.S.W.	0	0
156·0	67·7	91·7	69·9	78·9	83·6	69·0	75·6	29	29·67	Calm	9	8
155·4	65·7	89·0	69·4	79·1	86·1	68·0	75·6	31	32·46	Calm	7	8
151·5	59·9	89·9	65·5	76·8	80·6	64·2	71·3	13	13·89	Calm	4	5

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

TYPE-PRINTING SECTION.—With the exception of a little work done for the Forest Department, the energies of this office have been almost entirely devoted to the printing of volumes of the Account of the Operations of the Great Trigonometrical Survey, of Synoptical Volumes of triangulation, of pamphlets of Spirit-levelled Heights, and of the new Library Catalogue. The number of professional and special forms printed off during the past year has been exceptionally large. The following tabular statements show the money value of the work performed by this section :—

Statement of expenditure (Dr.) and amounts credited (Cr.) during the year 1887-88.

DR.	R	R	CR.	R	R
Superintendence	650		Departmental work, letter-press, forms, diagrams, &c.	13,730	
Establishment	8,169				13,730
Aid rendered by Computing Section	3,032				
Wear and tear of plant	492				
Contingencies	105				
		12,448			
Stores received from England	810				
		810			
Stores purchased in India	0		Miscellaneous letter-press, &c., extra-departmental work	108	108
Stationery from Stationery Office	580	580			
TOTAL	...	13,838	TOTAL	...	13,838

Statement of Departmental Work during the year 1887-88.

SPECIFICATION OF PRINT.	Number of pages.	Total number of pulls.	Number of* copies.	Value.
				R
Professional volumes	667	111,670	510	8,966
Synoptical	134	12,987	462	1,633
Pamphlets of spirit-levelled heights	74	9,670	510	684
Letter-press for charts, map headings and footnotes	119	6,022	30	524
Auxiliary Tables	3	170	1,052	43
Library Catalogue	96	2,860	82	150
Forms	86	16,552	160	933
Exploration	4	1,350	306	21
Miscellaneous	142	24,622	Not obtainable.	676
Index to Circular Orders	28	8,920	404	100
TOTAL	1,353†	194,823	...	13,730

* Approximate number.

† Equal to 1,994 pages of standard (foolscap) size.

Statement showing the amount and value of work done for other departments during the year 1887-88.

Departments.	Number of pages.	Total number of pulls.	Number of copies.	Value.
				R
Forest Department	23	802	...	108
TOTAL	23‡	802	...	108

‡ Equal to 31 pages of standard (foolscap) size.

The usual table showing the work annually performed by this section during the past five years is given below, the unit (a page of foolscap) being the same throughout—

	1883-84.	1884-85.	1885-86.	1886-87.	1887-88
Pages composed	1,489	1,505	1,340	1,516	1,994
„ printed	362,386	470,970	638,593	805,076	708,506

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

An analysis of the pages composed is as follows :—

		Pages.
Professional	Longitude operations	108
	Latitude „	827
	Great Arc Series section 8° to 18°	41
	South-East Coast and Ceylon Series	48
	Appendix to South Trigon volume	54
	Khanpisura Meridional Series	72
	Abu Meridional Series	29
	Mangalore Meridional Series	24
	South Konkan and Coast Series	10
	Total	1,213
Synoptical	Afghan Boundary Commission volume	129
	Great Arc Series Section 8° to 18°	17
	South-East Coast and Ceylon Series	1
	Khanpisura Meridional Series	18
	Mangalore Meridional Series	18
	South Konkan and Coast Series	10
	Total	193
Miscellaneous	Spirit-levelled Heights	75
	Letter-press for charts, map-headings and foot notes	83
	Auxiliary Tables	5
	Library Catalogue	102
	Forms, orders, memoranda, &c.	246
	Index to Circular Orders	42
	Explorations	4
	For Forest Department	31
	Total	588

Photo-zincographic Section.—This section has been employed in printing maps, charts, diagrams, &c., both to illustrate the volumes published by the office and for general use ; also in the printing from zinc of the Departmental professional forms, in which mathematical formulæ are largely employed ; it has moreover executed a good deal of work for the Forest Department and a certain amount for the Foreign, Military, and Quarter Master General's Departments. Besides the maps of the Nicobar Islands Survey and of the Mirzapur Survey, both recently concluded, and the charts of the work of the Coast Triangulation and of the Levelling Party, several sheets illustrative of trans-frontier work have been printed. Of these latter some have for the first time been done in two colors—*i.e.*, the hills in brown and the remaining details in black ; but, chiefly owing to the difficulty in registering, due to the small size of the negatives (of which no fewer than 12 are involved in the single sheet), and the consequent difficulty in satisfactorily joining the transfers, besides other reasons which need not be here mentioned, the result has hitherto not answered our expectations. The following statements exhibit the value and outturn of work done in this section :—

Statement of expenditure (Dr.) and amounts credited (Cr.) during the year 1887-88.

Dr. Cr.

	R	R		R	R
Superintendence	2,400		Departmental Maps, Forms, Diagrams, &c.	14,249	
Establishment	8,348				14,249
Contingencies	790				
		11,538			
Chemicals and Stores from England	1,000				
Paper received from England	520				
		1,520			
Chemicals and stores purchased in India	701				
Stationery (paper) from Stationery Office	1,037				
		1,738	Miscellaneous Maps, Plans, &c., Extra-departmental	4,099	
Shipping and Landing charges	20				4,099
		20			
Balance to credit of Department	...	3,532			
Total	...	18,348	Total	...	18,348

Note.—In addition to the credits above shewn, the section has realised by sale, on payment, of maps, &c., and paid into the treasury the sum of R498-4.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Statement showing the amount and value of work done for other Departments, &c., during the year 1887-88.

Departments, &c.	Photo-zincographic Printing.						Type printing.		No. of pulls.	No. of copies.	Value.	Remarks.
	No. of sheets or sections or subjects.	No. of negatives.	No. of photo-transfer prints.	No. of zinc plates.	No. of silver prints.	No. of blue prints.	No. of pages or items.	No. of copies.				
											R a.	
Forest Department .	83	195	234	43	8	346	...	...	4,422	9,784	3,249 2	(a) Will be realized and paid into the Treasury to credit of Government.
Foreign ditto .	4	17	17	4	...	...	...	...	60	60	223 12	
Military ditto .	1	...	12	2	...	...	...	...	150	150	147 0	
Quartermaster-General	6	24	36	4	...	96	...	...	550	266	467 7	(b) Already realised and included in the sums paid into the Treasury as given in note to the Dr. Cr. Statement.
Executive Engineer, Dehra Dun . .	23	...	...	...	...	23	...	...	...	23	11 8	
Messrs. Thacker, Spink & Co. . . .	1	2	16	1	...	...	...	...	125	500	(a) 106 3	
Other Publishers .	1	3	3	1	...	...	...	...	500	500	(b) 98 0	
Total .	119	241	318	55	8	465	...	...	5,807	11,283	4,303 0	

Statement of Departmental Work done during the year 1887-88.

Specification of Plate or Print.	Photozincographic Printing.									Type-printing.		Total No. of pulls.	No. of copies.	Value.	Remarks.
	Progress made.	Scale of maps.	Size of each sheet.	No. of sheets, sections or subjects.	No. of negatives.	No. of photo-transfer prints.	No. of zinc plates.	No. of silver prints.	No. of blue prints.	No. of pages or items.	No. of copies.				
		1 inch=												*R. a.*	
Nicobar Islands Survey, sheet No. 1	* F	2 m.	D. E.	1	...	...	1	...	...	...	...	100	100	21 8	
Do. do. do. Nos. 2 and 3	,,	2 ,,	,,	2	...	...	2	...	...	...	...	300	300	64 8	
Do. do. Triangulation Chart	,,	8 ,,	,,	1	...	...	1	...	...	...	...	30	30	8 4	
Nicobar Islands, Map of group	,,	5 ,,	,,	1	...	8	1	...	...	...	...	150	150	97 1	
Do. Map of Camorta Settlement	,,	¼ ,,	,,	1	8	8	1	...	...	...	...	153	153	129 15	
Secondary Triangulation Charts of East Coast Series Nos. 5, 6, 7	,,	2 ,,	,,	3	...	24	3	...	...	...	...	90	90	219 3	
Secondary Triangulation Charts of East Coast Series, Nos. 12 and 13	,,	2 ,,	,,	2	16	16	2	...	...	...	...	66	66	192 8	
Level Charts, Sheets Nos. 81 and 83 (2nd edition)	In Press	2 ,,	,,	2	12	....	2	...	...	...	...	...	...	68 6	
South-West Asia, Sheet No. 72	F	8 ,,	,,	1	1	7	1	...	...	...	...	62	62	58 2	
Plates of the Madras Meridional and Coast Series	,,	12 ,,	1/8 ,,	3	1	4	3	...	...	...	...	780	1,560	109 4	For Professional Volume of Southern Trigon.
Do. Bombay Longitudinal Series	,,	12 ,,	1/8 ,,	2	2	8	2	...	...	...	...	351	1,052	110 12	
Do. South Konkan Coast Series	,,	12 ,,	1/8 ,,	1	1	6	1	...	...	...	...	88	528	70 11	
Do. Madras Longitudinal Series	,,	12 ,,	1/8 ,,	2	2	12	2	...	...	...	...	176	1,056	141 6	
Do. Mangalore Meridional Series	,,	12 ,,	1/8 ,,	2	2	12	2	...	...	...	...	176	1,056	141 6	
Do. Madras Meridional Series	In Press	12 ,,	1/8 ,,	2	12	6	2	...	...	...	...	...	...	44 11	
Do. South-East Coast Series	,,	12 ,,	1/8 ,,	2	2	...	2	...	...	...	...	...	...	11 6	
Do. Khanpisura Meridional Series	,,	12 ,,	1/8 ,,	2	2	...	2	...	...	...	...	...	...	11 6	
Do. Singi Series	,,	12 ,,	1/8 ,,	1	½	...	1	...	...	...	...	...	...	5 11	
Do. Cutch Coast Series	,,	12 ,,	1/8 ,,	1	½	...	1	...	...	...	...	...	...	5 11	For Professional Volume of South-West Quadrilateral.
Do. Káthiáwár Series	,,	12 ,,	1/8 ,,	2	2	...	2	...	...	...	...	...	...	11 6	
Do. Abu Meridional Series	,,	12 ,,	1/8 ,,	1	1	...	1	...	...	...	...	...	...	5 11	
Diagram for preparation of above Plates	F	...	¼ ,,	2	2	10	2	...	...	...	...	17	61	79 6	
Graticule Sheet, North-West Trans Frontier 32° to 34°	,,	8 ,,	D. E.	1	...	...	1	...	...	...	...	24	24	7 8	
Do. do. 36° to 38°	,,	8 ,,	,,	1	...	...	1	...	...	...	...	24	24	7 8	
Do. do. 36° to 40°	,,	16 ,,	,,	1	6	6	1	...	...	...	...	12	12	88 13	
Do. North-East Trans-Frontier 34° to 36°	,,	8 ,,	,,	1	...	...	1	...	...	...	...	32	32	8 8	
Do. do. 38° to 40°	,,	16 ,,	,,	1	...	...	1	...	...	...	...	30	30	8 4	
Do. 42° to 44°	,,	8 ,,	,,	1	7	9	1	...	...	...	...	12	12	99 12	
Clinometer Height Indicator and Contouring Scale, and Diagrams connected therewith	,,	...	1/8 ,,	4	4	8	3	...	...	...	...	540	936	105 7	For Departmental use.
Gujarát Survey, Sheet No. 25, sec. 3, and Sheet No. 26, secs. 1 and 3	* ,,	½ ,,	D. E.	3	...	18	3	...	...	...	...	150	150	178 1	
Gujarat Survey, Sheet No. 81, Section 13	* F	¼ m.	,,	1	...	6	1	...	...	...	...	50	50	59 6	
Do. do. No. 25, Sections 1 and 4	* ,,	½ ,,	,,	2	...	12	2	...	...	...	...	100	100	118 12	
Do. do. No. 17, Section 1	* ,,	½ ,,	,,	1	...	6	1	...	...	...	...	50	50	59 6	
Do. do. No. 82, Section 5	* ,,	¼ ,,	,,	1	...	6	1	...	...	...	...	50	50	59 6	
Eastern Sind and Jodhpore Meridional Series Final Charts	,,	24 ,,	1/8 ,,	2	9	...	...	...	9	...	...	...	2	49 15	
Trans-Frontier Map No. 9 (Old Series)	* ,,	16 ,,	D. E.	1	...	...	...	...	...	...	...	50	50	10 12	

Statement of Departmental Work done during the year 1887-88—continued.

Specification of Plate or Print.	Photozincographic Printing.									Type-printing.		Total No. of pulls.	No. of copies.	Value.	Remarks.
	Progress made.	Scale of maps.	Size of each sheet.	No. of sheets, sections or subjects.	No. of negatives.	No. of Photo. transfer prints.	No. of zinc plates.	No. of silver prints.	No. of blue prints.	No. of pages or items.	No. of copies.				
		1 inch=												R a.	
Mechi River Survey	* F	¼ m.	D.E.	4	0	24	4	...	16	...	...	16	16	205 6	
Jeypore City Map	,,	1 ,,	1/16 ,,	8	8	...	...	...	24	...	...	...	24	46 12	
Chart of the Principal Chains of Triangles	,,	280 ,,	⅛ ,,	1	0	4	1	...	...	...	...	105	420	38 11	
Sketch map to illustrate memo. on Bhutan and Tibet	,,	12 ,,	¼ ,,	1	4	8	1	...	...	...	...	248	496	114 1	For General Report 1886-87.
Do. do. Course of the Lower Sanpo	,,	12 ,,	⅛ ,,	1	4	4	1	...	...	...	...	495	495	97 0	
Diagram showing variations in difference of Longitude	,,	...	,,	1	1	8	1	...	...	...	...	59	472	59 3	
Mirzapur Survey, Sheets, Nos. 201 N.-W. and S.-W.	,,	½ ,,	D.E.	2	12	12	2	...	...	...	...	313	313	180 8	
Do. do. 168 N.-E.	,,	½ ,,	,,	1	6	6	1	...	...	...	...	153	153	99 13	
Do. do. 200 S.-E. and 181 S.-W.	,,	½ ,,	,,	2	12	12	2	...	...	...	...	300	300	167 13	
Do. do. 168 S.-E. and S.-W.	In Press	½ ,,	,,	2	12	6	2	...	...	...	...	150	150	133 10	
Do. do. 201	F	1 ,,	,,	1	9	9	1	...	...	...	...	150	150	176 9	
Do. do. 181 N.-W.	In Press	½ ,,	,,	1	6	6	1	...	...	...	...	150	150	99 7	
Do. do. 184 S.-E.	,,	½ ,,	,,	1	6	...	...	...	...	...	...	...	...	34 3	
Do. Triangulation Chart (188—187)	F	4 ,,	,,	1	8	8	1	...	...	...	...	35	35	96 4	For General Report of the Mirzapur Survey.
North-East Trans-Frontier Sheets, 7 N.-W./1 and part of 6 S.-W./3	* ,,	2 ,,	,,	1	1	12	1	...	...	...	...	403	403	181 9	
North-East Trans-Frontier Sheet, 7 N.-W./3	* ,,	2 ,,	,,	1	1	12	1	...	...	...	...	385	385	181 9	
Turkestan Map, 6th Edition	* ,,	32 ,,	,,	5	...	42	5	...	...	...	...	313	378	295 10	
Diagram of conspicuous sun-spots	F	...	½ F.p.	1	1	2	1	...	...	...	...	108	216	25 5	For Survey Notes.
Map of Astor and Gilghit	* ,,	4 ,,	D.E.	1	...	2	1	...	...	...	...	2	2	2 1	
Diagram of North-West Quadrilateral	,,	48 ,,	,,	1	4	8	1	...	...	...	...	520	520	112 7	
Do. North-East do.	,,	48 ,,	½ ,,	1	3	6	1	...	...	...	...	260	520	89 5	
Do. South-West Quadrilateral	,,	48 ,,	¼ ,,	1	2	12	1	...	...	...	...	260	520	98 1	
Do. South-East do.	,,	48 ,,	¼ ,,	1	2	12	1	...	...	...	...	260	520	97 6	For New Map Catalogue.
Do. Triangulation east of 92°	In Press	48 ,,	¼ ,,	1	3	6	1	...	...	...	...	150	300	93 1	
Index to Level Charts and Data	,,	64 ,,	D.E.	1	6	...	...	...	...	...	...	...	...	34 3	
Do. the Groups of the Principal Triangulation	,,	64 ,,	⅛ ,,	1	1	...	...	...	...	...	...	...	...	5 11	
Diagram of the Southern Trigon	F	48 ,,	⅛ ,,	1	4	8	1	...	...	...	...	260	520	106 7	
Index to the Charts of the Coast Triangulation	In Press	64 ,,	D.E.	1	8	...	...	...	...	...	...	...	...	45 10	
Chart of the Spirit-levelling Operations in the Madras Presidency (1886-87)	,,	16 ,,	½ ,,	1	3	6	1	...	...	...	...	265	530	106 7	For Pamphlet of Spirit-levelled Heights No. 3, Madras Presidency.
Guide Map of Mussooree and Landour	,,	⅛ ,,	D.E.	1	8	32	3	...	...	...	...	600	600	301 0	
Punjab Survey, Sheets No. 332 N.-W./4 and 310 S.-E./2	,,	¼ ,,	,,	2	12	12	2	...	...	...	...	80	40	148 6	
Do. do. 310 S.-E./2	,,	½ ,,	¼ ,,	1	2	2	1	...	...	...	...	2	2	25 3	
Professional Forms for Departmental use	In Press & F.	...	...	35	30	202	35	...	...	...	...	13,350	10,932	2,740 12	

Miscellaneous Forms, &c., for Departmental use	F	...	...	18	12	66	15	...	...	...	...	2,865	2,290	726	2	
Other maps for office use, Surveyor-General's Office, &c.	F and In Press.	...	...	123	342	287	54	9	263	...	...	4,893	2,299	4,606	14	
Copies of Maps of other Departments taken for Departmental use.																
Kumaun and Garhwal Forest Survey, Sheets VIII to X, XXIV, XXIX, XXXIX to XLII, XLIV to XLVI, LI, LIII, LIV, LVII, LXII, LXVI, LXX, LXXIII, LXXIV	F	½ m.	D.E. & ½ D.E.	21	28	62	11	...	...	...	...	150	300	56	13	Copies retained, *for office record*, of maps, &c., requisitioned for by other departments; the cost of press-pulls and stationery being all that is here charged to the Survey Department: the numbers in columns 5 to 8 therefore stand *excluded* from the totals.
Berar Forest Survey, sheets 20 S. W., 20 S. E., 27 N. W./S. W., 26 N. W./1	,,	½ & ¼m.	D.E.	4	8	26	4	...	...	...	...	60	60	22	7	
Scales for Forest Survey Maps	,,	...	¼ ,,	1	...	4	1	...	...	...	...	4	8	1	10	
Illustrations of Sylviculture	,,	...	1/16 ,,	20	...	12	3	...	...	...	...	38	304	8	6	
Chota Nagpore Forest Survey, sheets 157 S. W./3, 127 N. E./2, 158 S. W./1, 158 S. W./2, 126 S. E./3, 127 N. E./4, 158 N. W./3, and addendum	,,	¼ m.	D.E.	8	27	49	8	...	...	...	...	120	120	57	14	
Bashahr Forest Survey sheet 346 S. E./3	,,	½ ,,	,,	1	...	14	2	...	...	...	...	30	15	6	6	
Dehra Dun Reserved Forests	,,	4 ,,	¼ ,,	1	2	4	1	...	...	...	...	15	15	3	5	
Government Forests in the Simla district, sheet 333 S. W./1, 2	,,	¼ ,,	,,	2	12	12	2	...	...	...	...	30	15	6	6	
Do. do. do. 333 N. W./3, 4	In Press	¼ ,,	,,	2	12	12	2	...	...	...	...	15	15	3	5	
Forest map of the Pangi Valley (Chamba)	F	1 ,,	,,	1	12	12	2	...	...	...	...	30	15	12	12	
Do. Kangra District	,,	2 ,,	,,	2	24	16	2	...	...	...	...	30	15	10	4	
Ramgarh Range Forest Division	,,	1 ,,	1/8 ,,	1	1	4	1	...	...	...	...	4	16	2	7	
Dehra Dun and Saharanpore Forest Division	,,	4 ,,	⅛ ,,	1	3	6	1	...	...	...	...	16	16	2	9	
Jaunsar Forest Division	,,	4 ,,	⅛ ,,	1	4	8	1	...	...	...	...	8	16	2	9	
Dufferin Hospital Buildings and Plans	,,	...	⅛ ,,	4	3	3	1	...	...	...	...	15	60	3	4	
Map of the Astor District shooting grounds	,,	4 m.	,,	1	3	3	1	...	...	...	...	15	15	5	2	
Other Maps	,,	2 ,,	½ ,,	1	3	3	1	...	...	...	...	10	10	2	2	
TOTAL	...	...	...	285	627	1,026	198	9	312	...	...	31,403	32,952	14,249	6	

* Additional prints of previous publications.—D. E. represents Double Elephant; Fp. represents Foolscap; F. represents Finished.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

SOLAR PHOTOGRAPHIC SECTION.—This section comprises a photographer and four *khalásis;* the photographer has two photo-helios in his charge, one giving 8-inch pictures and the other 12-inch. With the former he has to take two negatives each day that the sun is visible; the latter he only uses when phenomena are visible on the surface of the sun. The four following tables give the details of the work done in this section :—

Statement of expenditure (Dr.) and amounts credited (Cr.) during the year 1887-88.

DR.	₹	₹	CR.	₹	₹
Superintendence	600		Value of Negatives and Silver prints taken for the Solar Physics Committee, under authority from the Secretary of State for India (debitable to the Industry, Science and Art Departments).	3,261	3,261
Solar Photographer	1,070				
Establishment	258				
Contingencies	969				
		2,897			
Chemicals and Stores received from England	309				
		309			
Chemicals and Stores purchased in India	50				
		50			
Shipping and Landing charges	5				
		5			
TOTAL	...	3,261	TOTAL	...	3,261

Table of Working Facts for the year 1887-88.

1887-88.	NUMBER OF DAYS.				NUMBER OF NEGATIVES.										NUMBER OF WORKING DAYS WHEN SOLAR PHENOMENA WERE	
					Solar Phenomena.								TOTAL.			
	When negatives were taken.	Failures. From bad weather.	Failures. From various causes.	Total.	Spots and Faculæ. 8″	Spots and Faculæ. 12″	Spots only. 8″	Spots only. 12″	Faculæ only. 8″	Faculæ only. 12″	None. 8″	None. 12″	8″	12″	Visible.	Absent.
October	31	...	...	31	27	...	...	...	24	...	4	...	55	...	28	3
November	30	...	...	30	25	...	2	...	19	9	2	...	48	9	29	1
December	31	...	...	31	46	20	7	...	2	...	2	...	57	20	30	1
January	25	6	...	31	32	5	5	...	7	...	...	...	44	5	25	...
February	25	4	...	29	15	...	5	...	20	...	1	...	41	...	24	5
March	29	2	...	31	28	...	...	...	23	...	...	...	51	...	29	...
April	29	1	...	30	24	...	...	...	24	...	4	...	52	...	26	3
May	30	1	...	31	22	...	...	...	21	...	13	...	56	...	23	7
June	30	...	...	30	24	...	2	...	17	...	9	...	52	...	25	5
July	19	12	...	31	8	...	...	...	14	...	4	...	26	...	15	4
August	24	7	...	31	23	...	4	...	5	...	5	...	37	...	21	3
September	25	5	...	30	24	...	14	...	4	...	...	...	42	...	25	...
TOTAL	328	38	...	366	298	25	39	...	180	9	44	...	561	34	300	28

Eight hundred and twenty-eight silver prints of the 8-inch and 37 of the 12-inch pictures were prepared; and weekly despatches of both silver prints and negatives made as usual to the India Office.

Table of Percentages of daily visibility of the Sun and the presence of features.

Year.	In 100 days the sun was invisible on	In 100 days features were present on
1877-78	9 days (obtained from 273 days)	30 days (obtained from 248 working days).
1878-79	11 ,, ,, 89 ,,	28 ,, ,, 79 ,,
1879-80	14 ,, ,, 289 ,,	82 ,, ,, 232 ,,
1880-81	15 ,, ,, 365 ,,	96 ,, ,, 307 ,,
1881-82	10 ,, ,, 365 ,,	100 ,, ,, 328 ,,
1882-83	13 ,, ,, 365 ,,	100 ,, ,, 318 ,,
1883-84	21 ,, ,, 366 ,,	100 ,, ,, 285 ,,
1884-85	22 ,, ,, 365 ,,	100 ,, ,, 284 ,,
1885-86	21 ,, ,, 365 ,,	100 ,, ,, 290 ,,
1886-87	17 ,, ,, 365 ,,	98 ,, ,, 298 ,,
1887-88	10 ,, ,, 366 ,,	91 ,, ,, 300 ,,

Contrasting the percentages of days of invisibility above given with those for Greenwich, as furnished by the Astronomer Royal's Report, we have :—

Year.	At Dehra, year ending 30th September.	At Greenwich.
1880-81	15	60 } Year ending 20th May.
1881-82	10	45 }
1882-83	13	45
1883-84	21	41 } Year ending 31st December.
1884-85	22	58 }
1885-86	21	44
1886-87	17	Results not yet to hand.
1887-88	10	Ditto.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

DRAWING SECTION.—The details of the work done in this section are given in the tables which follow :—

Statement of expenditure (Dr.) and amounts credited (Cr.) during the year 1887-88.

DR.			CR.		
	₹ a.	₹ a.		₹ a.	₹ a.
Superintendence for 7 months .	8,069 0		Departmental Maps, Charts, &c..	45,503 6	
Establishment	37,897 0		Maps, &c., Extra-Departmental .	768 2	
Contingencies	205 8				
Stationery from Stationery Office	100 0				
TOTAL .	...	46,271 8	TOTAL .	...	46,271 8

Statement showing the value of work done for other Departments, &c., during the year 1887-88.

Department, &c.	Value.
	₹ a.
Quarter Master General's Department	388 12
Foreign Department	128 2
Forest Survey Office	36 0
Conservator of Forests, Quetta	29 5
Adjutant-General's Department	29 10
Revenue and Agricultural Department	19 10
Deputy Commissioner, Simla	16 3
Executive Engineer, North-Western Railway, Lahore	8 12
Military Department	37 8
Officer Commanding Sikkim Field Force	16 8
Deputy Assistant Quarter Master General, Allahabad	25 0
Inspector-General, Military Works	1 8
Messrs. Thacker, Spink & Co., Calcutta	31 4
TOTAL .	768 2

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

DRAWING SECTION.

Statement showing work performed during the year 1887-88.

Title of Map.	Number of Sheets.	Scale.	Remarks.
Atlas of India.		In. M.	
Sheet No. 28	1	1 = 4	Tabulated footnotes for Drawing Office, Calcutta.
General Maps.			
Afghanistan	4	1 = 24	Compiled in outline and preliminary press order given. Boundaries inserted on one copy.
Standard Maps.			
Darjeeling Survey.			
Sheets Nos. 1 to 7 (Daling Hills) . .	7	8 = 1	Completed headings, footnotes, references, &c., and final press order given (since superseded).
North-West Trans-Frontier Series.			
26 Maps	26	1 = 4	Compiled and final press order given.
2 Maps	2	1 = 4	Outlining and hand-printing completed. Hill shading in hand.
North-East Trans-Frontier Series.			
1 Map	1	1 = 8	Compiled on the ¼-inch scale for reduction to one-half; final press order given.
Nicobar Islands.			
Sheet No. 2, Kamorta Settlement . .	1	4 = 1	Completed headings, footnotes, references, &c., and final press order given.
North-Western Provinces.			
Sheet No. 201, Mirzapur District . .	1	1 = 1	Drawn for reduction to one-half. Completed headings, footnotes, references, &c., and final press order given.
Sheets Nos. 168 N.E., 168 S.E., 181 N.W., 181 S.W., 201 N.E., 201 N.W., and 201 S.W., Mirzapur district.	7	2 = 1	Completed headings, footnotes, references, &c., and final press order given.
Sheets Nos. 184 S.E., 185 S.E., and 200 S.W., Mirzapur district.	3	2 = 1	Completed headings, footnotes, references, &c. In press.
Punjab.			
Sheets Nos. 310 $\frac{\text{S.E.}}{2}$, 332 $\frac{\text{N.W.}}{4}$, 332 $\frac{\text{S.W.}}{1}$ and 332 $\frac{\text{S.W.}}{3}$; parts of the Simla and Kángra districts.	4	4 = 1	Completed headings, footnotes, references, &c., and final press order given for a preliminary issue for Local Revenue and Forest purposes. The headings, footnotes, references, &c., have also been prepared for reduction to one-half, but the publication is held over pending survey of adjoining sections.
Rajputana.			
Sheet No. 260 (2nd Edition) . . .	1	1 = 1	In hand.
Plans of Cities, Cantonments, &c.			
Mussooree and Landour, Guide to (3rd Edition.)	1	8 = 1	Prepared and final press order given.
Index Maps.			
N. E. Quadrilateral, N. W. Quadrilateral, S. E. Quadrilateral, S. W. Quadrilateral, Southern Trigon, and Triangulation East of 92° of G. T. Survey.	6	1 = 48	Drawn for reduction to one-half for the Map Catalogue, and final press order given.
Sections in which the Series of the principal Triangulation have been grouped for reduction.	1	1 = 192	Ditto ditto.
Level Charts and Data	1	1 = 64	Prepared for the Map Catalogue; final press order given.
Coast Triangulation	1	1 = 64	Prepared and final press order given.
Spirit-levelling Operations in the Madras Presidency.	1	1 = 16	Drawn on double the scale for reduction to one-half for pamphlet No. 3. Final press order given.
Triangulation of India	1	...	Corrected up to 1st October 1887 for Annual Report, 1886-87.
India—showing progress of Imperial Surveys.	1	...	Ditto ditto.
Punjab—Survey operations in the Himalayas.	1	...	Ditto ditto.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

DRAWING SECTION.

Statement showing work performed during the year 1887-88—contd.

Title of Map.	Number of Sheets.	Scale.	Remarks.
		In. M.	
Miscellaneous Maps.			
North-West Trans-Frontier—1 Map	1	1 = 12	Compiled from latest material, and final press order given.
Ditto ditto —1 Map	1	1 = 2	Commenced and then suspended.
Sketch Map to illustrate Colonel Tanner's Memo. on the course of the Sangpo.	1	1 = 12	Compiled on the ½-inch scale for reduction to two-thirds for Annual Report 1886-87. Final press order given.
Sketch Map to illustrate Colonel Tanner's Memo. on Explorations in Bhutan and Tibet.	1	1 = 12	Ditto ditto.
Blank Graticule Sheet 42° to 44° Latitude.	1	1 = 8	Prepared, and final press order given.
Ditto ditto 32° to 40° ditto .	1	1 = 32	Do. In press.
Ditto ditto 40° to 48° ditto .	1		
Ditto ditto 48° to 56° ditto .	1		
Captain Wahab's Clinometer Height Indicator and Contouring Scale (adapted for use with the theodolite.)	1	4 = 1	Prepared for reduction to one-half. Final press order given.
Diagrams of figures of the following G. T. Series :—			
Abu Meridional	1	1 = 12	Prepared on the ¼-inch scale for reduction to one-third for Professional Volumes. Final press order given.
Bombay Longitudinal . .	2		
Cutch Coast	1		
Gujarát (Guzerat) Longitudinal .	1		
Káthiáwár (Kattywar) Meridional	2		
Khanpisura Meridional . .	2		
Madras Longitudinal . .	2		
Madras Meridional and Coast .	1		
Mangalore Meridional . .	2		
Singi Meridional . . .	1		
South-East Coast . . .	1		
South Konkan Coast . . .	1		
Diagrams of Conspicuous Sun-spots . .	...	...	For Survey of India notes from October 1887 to January 1888. Final press order given.
Forms—Professional and others . .	24	...	Prepared and final press order given.
Graphical Illustration of the variations in differences of Longitude.	2	...	Prepared for Annual Report, 1886-87. Final press order given.
Plan of proposed extension to Store-room at Dehra Dun.	1	...	Not printed.
Charts.			
Triangulation Charts for Synoptical Volume $\frac{I}{B}$ of G. T. Survey	2	1 = 16	Prepared in 12 sheets on the ⅛-inch scale for reduction to one-half. In press.
Triangulation Charts, East Coast Series, Secondary Triangulation Charts, Nos. 12 and 13.	2	1 = 2	Corrected, and final press order given.
Triangulation Charts, Mirzapur Survey, Sheets Nos. 182 to 187, 197 to 202 and 212.	1	1 = 4	Ditto ditto.
Level Sheet No 66 (2nd Edition)—Parts of Umballa, Karnál, Patiála, Nábha, &c.	1	1 = 2	Prepared. In press.
Level Sheet No. 83 (2nd Edition)—Parts of Lahore, Ferozepore, and Amritsar.	1	1 = 2	Ditto. Ditto.
Level Sheet No. 88—Parts of Baháwalpur and Montgomery.	1	1 = 2	In hand.
Maps, coloured	3,302	...	

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

DRAWING SECTION.

Statement showing work performed during the year 1887-88—contd.

Maps Examined.	Number of Sheets.
General maps	36
District maps (portions of)	8
Original Standard maps	23
Trans-Frontier maps	27
Index Maps	10
Miscellaneous maps	101
Tracings of original maps	5
Photographic proofs of standard sheets, large scale plans, and various other maps	197
TOTAL	407

N. B.—In addition to the above many miscellaneous jobs, such as preparing a scale of degrees for the horizontal circle of Carey's 15-inch theodolite, transliteration of Russian names for Survey Maps, correcting orthography of names in Trans-Frontier and Route Maps, have been performed.

Statement of work done for other Departments, &c., during the year 1887-88.

Title of Maps.	Number of sheets.	Scale.	Remarks.
		In. M.	
General Maps.			
Route from Pekin across the Gobi Desert to Yarkand and Kashmir *viâ* the Mustagh Pass, 1886-87.	2	1 = 32	Prepared for Lieutenant F. E. Younghusband. Tracing supplied to Quarter Master General and another copy kept for record.
River Indus in the region of the Black Mountain.	1	1 = 2	Tracing prepared for the Hazara Field Force.
Routes in Tibet and Mongolia, by Dalgleish	14	1 = 8	For Quarter Master General.
Routes in North-West Trans-Frontier	6	1 = 4	Ditto ditto.
North-West Trans-Frontier	1	1 = 2	Prepared from original supplied by Foreign Office. Final press order given.
District Maps.			
Nyoungouk District Burma.—Geological Map of the Ruby Mines.	4	2 = 1	Prepared for the Revenue and Agricultural Department.
Mazhbi Settlements on the Chenab Canal.—Revised proposals of sites of.	3	2 = 1	Prepared for the Adjutant-General, India.
Simla Hill States.—Boundaries between Baghâl and Biláspur and Jubbal and Tarhoch.	1	1 = 2	Tracing made for Deputy Commissioner, Simla.
Quetta and Harnai	1	1 = 2	Ferrotype copy of original plane-table section coloured and completed for Conservator of Forests, Quetta.
Wazirabad	1	1 = 1	Tracing of Level data supplied to Executive Engineer, North-Western State Railway.
Standard Maps.			
Forest Surveys	19	Various.	Completed headings, footnotes, references, &c., and final press order given for Forest Survey Branch.
Maps, coloured	1,137	Various.	

Government of India Central Printing Office.—No. 12 S. G.—17-4-89—425.

1889. FILE No. 63.

GOVERNMENT OF INDIA. SERIAL No. 5.

REVENUE AND AGRICULTURAL DEPARTMENT.

SURVEYS.

RESOLUTION.

Circular No. $\frac{50}{63-5}$ S.

Simla, the 23rd July 1889.

SUBJECT.

Review of the Report on the operations of the Survey Department of India for the year 1887-88.

[W. F. C.]

G. C. Press, Simla.—No. 254 R. & A. D.—24-7-89.—990.

Circular No. $\frac{50}{63-5}$ S..

Extract from the Proceedings of the Government of India, in the Revenue and Agricultural Department (Surveys),—dated Simla, the 23rd July 1889.

READ—

The General Report on the operations of the Survey Department of India for the year 1887-88.

RESOLUTION.

The Survey Department was under the direction of Colonel H. R. Thuillier, R.E., throughout the year, and the report, which presents a record of varied and useful work in survey and exploration, indicates that the Department continues to be maintained in a state of high efficiency.

2. Field operations were prosecuted by twenty-six parties of which one was devoted to Trigonometrical Surveys, six to Topographical Surveys, nine to Cadastral and Forest Surveys, six to Traverse Surveys, one to Geographical Surveys, and three to Geodetic and Tidal and Levelling operations.

3. The Party employed on Trigonometrical Surveys completed the 370 miles remaining of secondary triangulation along the east coast of India. Secondary triangulation was also carried out for an aggregate length of 270 miles by the parties employed in Baluchistan as a basis for topographical surveys in that region. The work of the geodetic party comprised the measurement of seven arcs of longitude in Southern India; and the Tidal Survey party continued its observations with self-registering tide gauges, at the several stations along the coast where tidal observatories are established, and the connected operations of spirit levelling.

4. Geographical Surveys and Explorations have been carried out vigorously in Upper Burma, with the result that triangulation has been extended over an area of 23,000 square miles, and that nearly 21,000 square miles have been surveyed and mapped on the $\frac{1}{4}$ inch scale. The survey officers who accompanied the Hukong valley expedition on the eastern, and the Black Mountain expedition on the western frontier, succeeded in mapping large areas in comparatively unknown country on both sides of India, while a valuable addition was made to the geographical knowledge of Afghanistan and its borders by the native Surveyor deputed with the Afghan Boundary Rectification Commission. A reconnaissance along the Nepal boundary has supplied a rough basis for a more accurate and detailed survey of the northern frontier when opportunity offers, and interesting additional information regarding Bhutan and Thibet has been obtained from the adventurous travels of native explorers trained and sent thither by the Survey Department. On the whole, the work accomplished during the year in Geographical Exploration is satisfactory, and shows that this important and difficult section of the duties of the Department has received a full share of attention.

5. The number of parties devoted to Topographical and Forest Surveys within India was reduced from eight to six, one party having been transferred to Upper Burma for Geographical, and the other to the Central Provinces for Forest Surveys. Belgaum, Dharwar and Guzerat in Bombay, and Madura and the Native States of Travancore and Cochin in Madras, were the field of operations in the Southern Presidencies. The party in Madras took over the Topographical programme from the Provincial Survey Department, and by thus relieving the latter of this class of work enabled it to extend the surveys required for purposes of settlement. In Northern India the Military Surveys in Baluchistan on the

$\frac{1}{2}$ inch scale were continued, and a party in the Punjab operated in Kangra and the Simla Hill States, and provided, in the British districts within these tracts, a skeleton traverse or frame which it is intended that the Settlement Department should fill in for purposes of land assessment in accordance with the system advocated in the 8th and 9th paragraphs of the Survey Resolution of 1882. New topographical maps were also constructed for a large area in the Punjab by the traverse party employed in that Province; and a topographical section, working in conjunction with a cadastral party, completed the survey of the district of Mirzapur in the North-Western Provinces. The aggregate outturn amounted to 15,673 square miles, forming a substantial addition to the data in course of collection for the new maps which are constantly being required for purposes of general administration.

6. Forest Surveys conducted by the Survey of India Department were carried out in the Central Provinces, Lower Burma, the North-Western Provinces, Orissa, and Bombay. The outturn in the forests of Hoshangabad in the Central Provinces was small, as is usual in initiating operations in a difficult and unhealthy tract. In Burma, the absence of disturbances enabled a larger area to be surveyed. In the North-Western Provinces and Orissa, the Forest Surveys were performed by parties employed on cadastral work, and in Bombay by the two Topographical parties engaged in the Presidency. Under recent arrangements with the Government of Bombay, one of these parties will in future be exclusively employed on the survey of Government Forests, and will compile complete maps on a 4 instead of an 8 inch scale. This change, while admitting of a larger outturn of work, will not affect the value of the maps for the purposes of forest management, for which they are primarily needed.

7. In pursuance of the programme laid down four years ago, the greater part of the available survey force is now devoted to work designed to combine the requirements of Revenue Administration with the demands of Cartography. Under this head may be included the Forest Surveys already referred to, as well as Cadastral and Traverse Surveys, which occupied thirteen out of twenty-six parties. The diversion of what may be termed unremunerative to remunerative work is indicated by the following table in which the classification of the several parties employed in 1884-85 and 1887-88 is based upon the character of the work upon which they were employed. The first term "necessary" implies that for military or administrative purposes the survey is urgently required. The second term "unremunerative" comprises topographical surveys, which can be postponed without great inconvenience to the Administration.

	1884-85.			1887-88.		
	Necessary.	Unremunerative.	Remunerative.	Necessary.	Unremunerative.	Remunerative.
Number of parties...	8	11	7	11	2	13
Total Cost Rs.	(*a*) 3,02,000	7,15,000	8,66,000	(*a*) 4,72,000	1,43,000	13,65,000

(*a*) Exclusive of cost of 4 scientific parties (Coast Triangulation, Tidal and Levelling and Astronomical).

Taking Cadastral and Traverse Surveys together, the area covered during the year was upwards of 25,000 square miles. These extensive operations will aid materially in securing the punctual assessment of large tracts of country in which the settlement engagements are about to expire; and the Government of India desires to record its appreciation of the cordiality and zeal with which the Survey Department has lent itself to carrying out the programme, imposed upon it by pressing fiscal and administrative considerations, in this important section of its duties.

8. Cadastral Surveys, involving the plotting of interior details, have been restricted to tracts where no village maps and no village officials trained in survey at present exist, or where, owing to the inferior training of the village staff, the existing village maps have become inaccurate and obsolete. Seven parties were thus employed in the Central and North-Western Provinces, Assam, Burma, and Bengal, and the aggregate outturn was 5,435 square miles. The system pursued varied in each case; but in every instance measures are, as far as possible, being taken to train the local and permanent officials to assist in the work and to maintain the maps and records provided by the professional survey.

Owing to the necessity for adapting the plan of operations to the widely differing conditions and circumstances of the tracts in which Cadastral Surveys were prosecuted, no useful conclusion can be drawn from a comparison of cost rates. But efforts have been continuously and systematically directed to reducing the cost to the lowest possible limits, and the average rate, which in 1884-85 was about 300 Rs. per square mile, is now brought down to something like 150 Rs. per square mile.

9. In Traversing, the principal field of operations continued to be the Central Provinces, where five parties were engaged in providing skeleton plots on the 16 inch scale, and completed 14,287 square miles. These plots are intended to furnish a scientific framework and check for the field survey by trained village officials which follows. The only other Province in which traversing formed the special work of a survey party was the Punjab, where one party was employed and furnished skeletons for 5,795 square miles. In this case the object of the survey was to provide correct outlines for new topographical maps, the details being taken from the village maps compiled by the Land Record establishment, on the accuracy of which the traverse at the same time serves as a check. The average cost of traverse surveys did not much exceed 20 Rs. per square mile.

10. It remains to notice the good work done by the Head Quarters Offices. Of new maps, 4,062 were published during the year, and heavy demands continued to be made on the Drawing Office for trans-frontier maps and maps of Upper Burma. The Photographic and Lithographic Offices show the large outturn of 1,203,861 copies issued during the year, which is in some measure due to requisitions for high class illustrations for archæological and other reports, for the production of which the copying processes perfected in the Photographic Office are admirably adapted. The transactions of the Mathematical Instrument Office also increased; the number of instruments supplied being 57,293, and of those received into store 70,093.

11. In his concluding remarks in Part I of the Report, the Surveyor General alludes to the difficulty of providing officers to superintend the various field operations, and the necessity of further recruitment in view of the large number of prospective retirements. These matters are under the separate consideration of the Government of India.

ORDER.—Ordered that the foregoing Resolution be forwarded to the Surveyor General of India, to the Local Governments and Administrations, noted on the margin, and to the Foreign and Military Departments.

Madras.	Punjab.
Bombay.	Central Provinces.
Bengal.	Burma.
North-Western Provinces and Oudh.	Assam.
	Coorg.

Ordered also that it be published in the *Supplement to the Gazette of India.*

(True Extract.)

E. C. BUCK,

Secretary to the Government of India.

Photo-etching.

Survey of India Offices, Calcutta, March 1890.

THE PHOTOGRAPHIC & LITHOGRAPHIC OFFICE, CALCUTTA.

SURVEY OF INDIA DEPARTMENT.

Built in 1889.

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India Department

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1888-89.

PREPARED UNDER THE DIRECTION OF

COLONEL H. R. THUILLIER, R.E.,

SURVEYOR-GENERAL OF INDIA.

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY.

CALCUTTA:

PRINTED BY THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.

1890.

Survey of India Department.

Corrigenda to General Report for 1888-89.

Page 41, para. 216, in marginal establishment, for "17" read "176" (Field Surveyors).

„ 42, line 12, for "monthly" read "season's".

„ „ line 14, erase the words "in one month".

„ „ line 15, erase the word "monthly".

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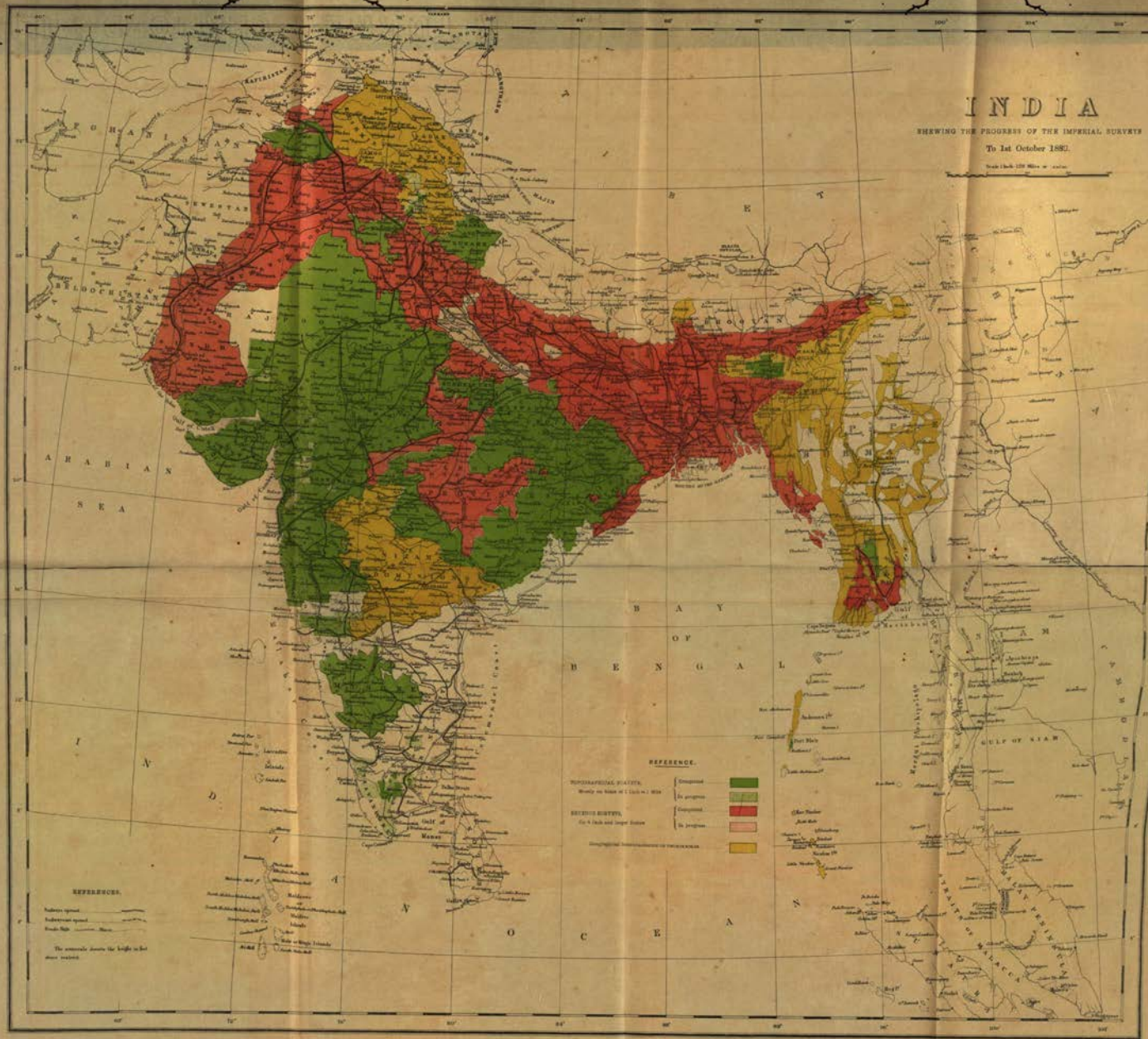
OF
INDIA
SHOWING COLONEL LAMBTONS NET WORK OF TRIANGULATION IN SOUTHERN INDIA.
THE MERIDIONAL AND LONGITUDINAL CHAINS OF PRINCIPAL TRIANGLES.
THE BASE LINES MEASURED WITH THE COLBY APPARATUS.
THE LINES OF THE SPIRIT LEVELLING OPERATIONS.
THE ASTRONOMICAL PENDULUM & TIDAL STATIONS.
THE LONGITUDINAL ARCS.
AND THE SECONDARY TRIANGULATION TO FIX THE PEAKS OF
THE HIMALAYAN & THE SOOLIMANI RANGES.
AND THE POSITIONS OF BANGKOK AND KANDAHAR.
REFERENCES
BAY OF BENGAL
CEYLON
BOMBAY
MADRAS
CALCUTTA

TO ACCOMPANY SURVEYOR GENERAL'S REPORT FOR 1881-82.



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TO THE
GREAT TRIGONOMETRICAL SURVEY
OF
INDIA
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GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1888-89.

PART I.

INTRODUCTORY.

The operations of the Department that are now reported on are for the year ending 30th September 1889.

2. The administration of the Department and the superintendence of the Topographical Branch have remained in the hands of Colonel H. R. Thuillier, R.E., during the year, except for three months, from the 11th April 1889, while he was absent on privilege leave; during this period Colonel J. Sconce, S.C., officiated as Surveyor-General. The supervision of the Revenue Branch has been carried on, as before, by Colonel J. Sconce, S.C., his place being taken by Lieutenant-Colonel C. Strahan, R.E., during the three months he officiated in the higher post. Colonel C. T. Haig, R.E., the Deputy Surveyor-General in charge of the Trigonometrical Branch, proceeded on furlough on the 15th November 1888, when Lieutenant-Colonel G. Strahan, R.E., was appointed to officiate, and he has superintended that Branch from that date.

3. The Cartographic and other offices at the Head-Quarters have been superintended, as usual, by three Assistant Surveyor-Generals, *viz.*, the Drawing and Engraving offices by Lieutenant-Colonel C. Strahan, R.E., the Photographic and Lithographic offices by Colonel J. Waterhouse, S.C., and the Correspondence and Mathematical Instrument offices by Colonel D. Macdonald, S.C., Lieutenant-Colonel A. W. Baird, R.E., and Lieutenant-Colonel M. W. Rogers, R.E., at different periods.

4. The various field operations were carried on during the year by 25 parties; of these, one party was employed on trigonometrical surveys, three on topographical surveys, four on forest surveys, seven on cadastral surveys, six on traverse surveys, three on geodetic and tidal operations, and one on geographical surveys. They are shown collectively in the following tabular statement, according to the nature of the operations on which they were employed:—

Statement of Survey Operations and Parties.

Number of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
	Trigonometrical Survey.				
24	Burma . . .	11	Mr. E. C. Ryall. Captain S. G. Burrard, R.E. Mr. J. Eccles, M.A.	.....	D. S. G. Trig.
	Topographical Surveys.				
10	Gujarat and Southern Maratha Country.	12	Lieutenant-Colonel H. S. Hutchinson, S.C.	2″ = 1 mile for reduction to half scale.	Ditto Rev.
15	Baluchistan . . .	14	Lieutenant-Colonel T. H. Holdich, R.E.	2″ = 1 mile, ½″ = 1 mile, and ¼″ = 1 mile for reproduction.	Ditto Topo.
18	Himalayas . . .	16	Colonel H. C. B. Tanner, Bo, S.C.	2″ = 1 mile for reproduction and 4″ = 1 mile for reproduction and reduction to half scale.	Ditto Trig.

Statement of Survey Operations and Parties—continued.

Number of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
	Forest Surveys.				
14	Central Provinces .	18	Colonel J. R. Wilmer, S.C.	4″ = 1 mile for reproduction.	D. S. G. Topo.
17	Bombay . . .	20	Colonel A. Pullan, S.C.	4″ = 1 mile and 8″ = 1 mile for reproduction.	Ditto ditto.
19	Madras . . .	22	Major J. R. McCullagh, R.E.	4″ = 1 mile for reproduction.	Ditto ditto.
29	Lower Burma . .	24	Lieutenant-Colonel R. Beavan, S.C.	2″ = 1 mile and 4″ = 1 mile for reproduction.	Ditto ditto.
	Cadastral Surveys.				
2	Bilaspur . . .	25	Lieutenant-Colonel E. H. Steel, S. C.	16″ = 1 mile for reproduction.	Ditto Rev.
4	Western Dooars . .	27	Lieutenant-Colonel S. H. Cowan, S.C. Mr. H. T. Hanby.	Ditto ditto .	Ditto ditto.
4*a*	Srinagar and Burdwan .	31	Mr. G. B. Scott . . .	Ditto ditto .	Ditto ditto.
5	Tarai, Jhansi, and Lalitpur	35	Lieutenant-Colonel J. E. Sandeman, S.C.	Ditto ditto .	Ditto ditto.
6	Sibsagar . . .	41	Mr. E. C. Barrett . .	16″ = 1 mile for reproduction.	Ditto ditto.
7	Thongwa . . .	43	Mr. F. W. Kelly . .	Ditto ditto .	Ditto ditto.
8	Bengal and Orissa .	45	Colonel W. Barron, S.C. Lieutenant-Colonel S. H. Cowan, S.C.	16″ = 1 mile and 4″ = 1 mile for reproduction, and 2″ = 1 mile for reduction to half scale.	Ditto ditto.
Det.	Chittagong . . .	52	Mr. W. J. O'Sullivan . .	16″ = 1 mile for reproduction.	Ditto ditto.
	Traverse Surveys.				
1	Punjab . . .	55	Colonel F. Coddington, S.C. Colonel D. Macdonald, S.C.	2″ = 1 mile compilation for reduction to half scale.	Ditto ditto.
3	Nagpur and Wardha .	57	Colonel W. H. Wilkins, S.C.	16″ = 1 mile (skeleton plots).	Ditto ditto.
9	Chanda and Bhandara .	58	Mr. G. H. Cooke . .	Ditto ditto .	Ditto ditto.
11	Chhindwara and Nimar	59	Mr. W. H. Patterson . .	Ditto ditto .	Ditto ditto.
12	Saugor and Balaghat .	60	Mr. E. J. Jackson . . Mr. E. G. Little.	Ditto ditto .	Ditto ditto.
13	Hoshangabad and Betul	63	Mr. A. D'Souza . . .	Ditto ditto .	Ditto ditto.
	Geodetic.				
22 & 23	Southern India . .	65	Lieutenant S.G. Burrard, R.E. Mr. J. Eccles, M.A. . .	.....	Ditto Trig.
	Tidal and Levelling Operations.				
25	India	66	Lieutenant-Colonel M. W. Rogers, R.E. Mr. G. Belcham . . .	.....	Ditto ditto.
	Geographical Surveys.				
21	Upper Burma . .	68	Major J. R. Hobday, S.C. .	¼″ = 1 mile . .	Ditto Topo.
Det.	Lushai Hills . .	70	Lieutenant W. H. Pollen, R.E. Mr. A. J. James.	¼″ = 1 mile . .	Ditto ditto.

These operations are described in detail in Part II in the order in which they appear in the above statement, and the following is a summary thereof :—

TRIGONOMETRICAL SURVEYS.

5. The secondary triangulation of the East Coast of India having been completed during the year previous to that under review, the party was transferred to the coast of Lower Burma in continuation of the same scheme, *viz.*, the fixing of artificial beacons as well as various natural land-marks at convenient intervals within sight of the sea, for the Marine Survey Department to base their

operations upon: 157 miles of triangulation of this description have been completed, reaching from Cape Negrais to Sandoway.

6. A commencement of the principal triangulation for Upper Burma was made by the same party on the meridian of 97°. The series emanates from the side Mya-ya-beng-kyo to Theyekhu (of the Eastern Frontier Series) near Toungoo, and is destined to proceed northwards as far as Mandalay in the first instance. Owing to climatic and other difficulties, the progress was limited to the selection of two figures, and the building of the observing stations at the angles thereof.

7. The series of secondary triangles, emanating from the Great Indus Series and running along the parallel of 30° N. latitude, which was commenced last year to furnish a reliable basis for the surveys that are being carried out in Baluchistan, has been continued by the topographical party employed there and extended over a direct distance of 115 miles as far as Quetta. Observations at four stations still remain to carry the series to the Khwaja Amran range.

TOPOGRAPHICAL SURVEYS.

8. The number of parties employed on this class of survey has again been reduced during the past year. Owing to the urgent demands for forest surveys, two of the six parties hitherto engaged on topographical work have been diverted for employment solely on the survey of forests in the Bombay and Madras Presidencies respectively, and one of the two parties employed on the military survey in Baluchistan, *viz.*, No. 16, has been disbanded in compliance with the orders of the Government. Thus the number of parties devoted to topographical surveys during the year under review has been reduced from six to three parties. These were employed, one in Bombay, one in Baluchistan, and one in the Himalayas, and each of them continued the operations on which it had been engaged during the previous season.

9. In the Bombay Presidency, operations were carried on in the Belgaum district and in Gujarat. In Baluchistan, the 2-inch military surveys in the neighbourhood of Quetta and Pishin have been almost completed, and considerable progress has been made with the ½-inch surveys. The party working in the Himalayas has continued the survey of the Kángra district and of the Hill States about Simla: the Native feudatory tracts of the latter are being surveyed on the 2-inch scale, and the very high mountainous portions of both British and Native States on the 1-inch scale.

10. In addition to the work executed by the regular topographical parties, various small areas were surveyed in detail by other parties in connection with the Revenue and Forest survey operations, in order to complete the topography of compact tracts.

11. The compilation of new topographical maps of the plains of the Punjab on an accurate traverse basis has been steadily proceeded with by the traverse party employed there, the topography being obtained by reduction from the village maps prepared by the Settlement Department and subsequently tested in the field. A large area of country was thus mapped, belonging principally to districts Jhang and Ferozepore.

12. The areas topographically surveyed on various scales during the year amount to 9,002 square miles, against 15,673 square miles in the previous year, when twice as many parties were employed. The total is made up as follows:—

3,628	square	miles	surveyed on the	½-inch scale.
70	„	„	„	1-inch „
4,906	„	„	„	2-inch „
398	„	„	„	4-inch „

This out-turn does not include the area of map compilation in the Punjab referred to in the preceding paragraph, which amounted to 2,748 square miles on the 2-inch scale.

FOREST SURVEYS.

13. Four parties were employed on forest surveys, working in the Central Provinces, in the Bombay and Madras Presidencies, and in Lower Burma respectively; as well as a detachment in Bengal, working in conjunction with the cadastral party engaged in the survey of Angul in Orissa.

14. In the Central Provinces, the party continued the work of the previous season, *viz.*, the survey of the first and second class reserves in the Hoshangabad and Betul districts. It also undertook for the first time the classification of the forest and soils therein, which has been successfully worked and furnishes a valuable addition for forest administration. Owing to the unhealthiness of the tracts under survey, and the consequent short period of four months in which field operations can be carried on, the annual out-turn of work is necessarily somewhat small.

15. In Bombay, the forest party has worked directly under the orders of the Bombay Government, and has been engaged chiefly on 4-inch surveys of forest reserves in the Satara, Nasik, Poona and North Kanara districts. A small area was surveyed on the 8-inch scale in Thana district. The out-turn yielded by the party is very satisfactory in spite of the malarious nature of the climate in which part of the operations were carried on.

16. In Madras, the party, which had previously been employed on topographical surveys in that Presidency, was diverted therefrom and placed exclusively on forest surveys. The operations have been carried on in the districts of Madura, Tinnevelly and Salem. The country is exceedingly difficult to survey and the forests are notoriously unhealthy, and hence only a comparatively small out-turn was obtained.

17. The party in Lower Burma continued the work of the previous season, *viz.*, the 4-inch survey of forest reserves in Prome and Toungoo districts and the 2-inch survey of intervening tracts. Here also the country operated in was found to be exceedingly difficult owing to the absence of roads and the thickness of the undergrowth, but a fair out-turn was accomplished.

18. In Bengal, a detachment of the cadastral party in Orissa was employed on the survey of the forest reserves in the Government estate of Angul, on the scale of 2 inches to the mile, which scale was specially fixed by the Government of Bengal.

19. The total area of forest reserves surveyed during the year amounted to 1,655 square miles, as against 893 square miles executed last year by three parties. The areas obtained on the various scales are as under:—

215	square miles	surveyed	on the	2-inch	scale.
1,418	„	„	„	4-inch	„
22	„	„	„	8-inch	„

CADASTRAL SURVEYS.

20. Seven parties and one detachment have been employed on cadastral surveys during the year; of these, six continued the operations of the previous year in the Central Provinces, in Bengal, in the North-West Provinces, in Assam and in Burma, whilst the seventh party was transferred from the North-West Provinces to initiate the survey of Jalpaiguri in Bengal. A small detachment was also formed for the commencement of the survey of Chittagong.

(1) In the Central Provinces, that portion of the Bilaspur district which was required to be cadastrally surveyed was completed. The survey has occupied three and a half seasons, and the operations have included the preparation of all the village papers required for settlement purposes.

(2) The field-work in Basti and Mirzapur, North-West Provinces, having been completed last year, the party that had been employed in those districts was transferred to Bengal to commence the survey of a portion of district Jalpaiguri, Western Dooars; a small office establishment was sent to the head-quarter office in Calcutta to complete the records of Basti and Mirzapur. This party had to contend against exceptional difficulties, the most serious of which was the excessive sickness caused by the malarious climate: the unwillingness of the inhabitants to render any assistance, the heavy jungle over some parts of the country, and other difficulties connected with commencing work in an entirely new country all tended to delay progress, and consequently the area turned out by this party was small compared to those completed in more favourable localities.

(3) The survey of the Srinagar Wards' estate in Bengal, which is composed of detached villages and scattered groups of villages in districts Bhagalpur, Monghyr, Purneah, and Maldah, was completed. It had been intended, as far as possible, to train and utilise village officials for the interior survey of the fields, but as

none were available, *amins* from the North-West Provinces had to be employed. All the village records have been completed and made over to the Settlement officer. The same party commenced the survey of the Burdwan Raj Khas Mehals and finished the survey and records of the villages scattered over districts Beerbhoom and Burdwan, as well as nearly all those in district Midnapore. The villages in district Bankoora were also commenced, but immense confusion was found to prevail there as to what was the property of the Raj.

(4) The party employed in the North-West Provinces completed the traverse survey and commenced the detail survey of the Jhansi district, employing the village *patwáris* for the latter purpose with excellent results: the traverse surveyors, as they finished their work in Jhansi, were transferred for the same purpose to the Lalitpur district, where only a skeleton traverse survey is required. The detachment employed in the Tarai district has completed the cadastral survey of the selected tracts required; the village *patwáris* were in this case also successfully employed as cadastral surveyors.

(5) The party engaged in Assam has surveyed an area of 657 square miles in the Sibsagar district; the field survey was done partly by imported agency, but a considerable share has been done by the *mandals* (village headmen), who have proved themselves to be efficient surveyors: it is hoped that during next year it will be possible to do without any imported *amins*.

(6) The cadastral survey in Burma has been almost entirely confined to the district of Thongwa, only some small revision surveys having been made in Akyab. It is anticipated that during 1889-90 the traversing of Thongwa will be completed and that only about 400 square miles of cadastral work will remain. The scheme for the permanent employment of Burmans, in place of the Hindustani *amins*, has progressed very satisfactorily during this season, and for the first time the Burman surveyors have out-numbered the Hindustanis.

(7) The party which was last year engaged on the survey of the City of Calcutta and other detached surveys in Bengal has been similarly employed this year. Besides the work connected with the survey of Calcutta, which will be referred to hereafter, one section of this party undertook the cadastral surveys of the estates of Kujang and Kanika in Orissa; here, as in other parts of Bengal, considerable difficulty was met with, and it was found impossible to carry on the work without importing trained men from other parts of India; the survey of Kujang was nearly finished, as well as about 50 square miles of Kanika. Another section completed the cadastral work in the Government estate of Angul in Orissa, which had been begun during the previous year. A fourth section was engaged in the survey of the Sankarpur and Maldwar Wards' estates, in the districts of Dinagepore and Purneah, which consist of villages scattered over the country, either isolated or in blocks, and even sometimes only containing small groups of fields detached from the villages to which they belong; both these estates were finished: the detached character of the villages has rendered the survey very tedious.

A detachment was formed from the parties in Bengal for the cadastral survey of Old Thana Ramoo in the Chittagong district, which was commenced. Here also considerable difficulties were met with, local labour being unprocurable. The work was necessarily carried on almost entirely by imported *amins* and measurers.

21. The areas that have been surveyed cadastrally in the different provinces are as follows:—

	Square miles.
Central Provinces	915
N. W. Provinces	1,203
Assam	657
Burma	826
Bengal	1,235
TOTAL	4,836

This shows a decrease of 599 square miles on last year's out-turn, which is due mainly to the transfer of one party from the North-West Provinces to initiate a new survey in Bengal.

CITY SURVEY.

22. The identification and mapping of the boundaries of the different holdings in Calcutta have been proceeded with as fast as circumstances would admit, but much time was lost by the non-attendance of proprietors. Disputes are settled by a Deputy Collector, who holds his Court in the Survey Office twice a week. It has been lately decided that the boundaries of holdings in the *taluk* of Sutanoti should be shown, which adds about 5,500 to a previous total of 13,580 holdings, the boundaries of each of which have to be separately enquired into on the spot in the presence of the proprietor and traced out on the map; about 6,100 still remain to be done. The drawing of the fair maps for publication is progressing, but none have been completely finished yet, in consequence of disputed or incomplete boundaries. When ready, these sheets will be placed in the Municipal Office for a certain time, to allow of their being inspected and the boundaries criticised by all who may be interested in them; after the adjustment of any faults that may be then brought to light, they will be finally passed, printed and made available to the public.

TRAVERSE SURVEYS.

23. The traverse operations on which the party in the plains of the Punjab is engaged have been continued, their object being to obtain topographical maps of the country, by reduction of the details from the village maps of the Settlement Department. The traversing was carried on in the districts of Jhang, Gujranwala, Sialkot and Gujrat, of which the first three have been completed.

24. In the Central Provinces, the traverse surveys which had been commenced in districts Nagpur, Wardha, Hoshangabad, Chhindwara, Betul and Saugor, were proceeded with, and the first four of these districts have been completed, while Betul and Saugor have only small areas left. Operations have been begun in four new districts, *viz.*, Chanda, Bhandara, Balaghat and Nimar, the last of which has also been finished. The areas in the five districts which remain incomplete will, it is expected, be accomplished in 1889-90 by the one party which is left in the Central Provinces. The Mandla district is the only one that will then remain to be done. The skeleton plots of villages, for the formation of which these traverse surveys are being conducted, are furnished as soon as possible after the field-work is completed, to the Settlement officers, who will eventually carry out by the agency of village officials the survey of fields based on the points thus fixed.

25. The areas which have been traversed are—

	Square miles.
Punjab	7,308
Central Provinces	16,091
TOTAL	23,399

The areas traversed in the two previous seasons by the same number of parties were respectively 16,661 and 20,082 square miles.

SPECIAL OPERATIONS.

26. During the present year it again became necessary, owing to the paucity of officers, to suspend temporarily the electro-telegraphic operations for longitude, and to establish in lieu of them latitude observations on the meridian of 80° on the Jubbulpore Meridional Series, in continuation of the work of 1886-87. Seven stations were observed at, ranging from the parallel of 19° 49½′ on the North to 16° 26′ on the South.

27. The tidal operations have been continued as usual; observations with the self-registering tide gauges were taken at eighteen stations in India, Burma, Ceylon, Aden, and the Andaman Islands. One old observatory, *viz.*, Mormugao, at which the work had been completed, was dismantled, and three new ones at Shialbet, Prince's Dock, and Mergui have been established.

Spirit-levelling in connection with the tidal work has been carried on as before, the lines levelled lying between Bangalore and Mangalore, and between Bidar and Hyderabad, aggregating 323 miles in length.

GEOGRAPHICAL SURVEYS AND EXPLORATIONS.

27. The reconnaissance survey of Upper Burma by the party under Major Hobday has proceeded steadily during the year; the operations were similar in character to those carried on in the two preceding seasons, and they have again resulted in a very large addition to our geographical knowledge of this recently acquired territory. Survey officers accompanied the various military expeditions which were organised during the year and proceeded to the Chin country, to Karenni and the Southern Shan States, to the Northern Shan States, and to Mogoung and other parts of the Bhamo district against the Kachin tribes. Surveys of a more regular character were also carried on in the Minbu, Myingyan, Sagain and the Ruby Mines districts.

The year's out-turn amounted to 20,510 square miles, mapped on the $\frac{1}{4}$-inch scale, of which the greater portion lies in the Shan States and in the Bhamo district. These operations bring the total area mapped by the party during the three years it has been engaged in Upper Burma up to 52,290 square miles; this large result reflects much credit on Major Hobday, who has had charge of the survey operations since the annexation of the country, and he has been ably seconded by Captain Jackson, R.E., who has been attached to the party throughout, and assisted by Mr. Ogle and others. It is gratifying to report that the Gill Memorial Medal for 1889 was awarded by the Council of the Royal Geographical Society to Mr. M. J. Ogle, Surveyor, in recognition of his excellent survey work on the North-Eastern Frontier and in Burma.

28. A small survey party accompanied the Lushai expedition of 1888-89. The area of new country mapped on the $\frac{1}{4}$-inch scale amounted to 540 square miles, besides about 210 square miles which were roughly reconnoitred. The work done was small, which was due to the illness and subsequent death of the officer in charge, Lieutenant Pollen, R.E., but it gives valuable additional knowledge of the country traversed by the force.

29. On the North-West Frontier the party employed in Baluchistan effected, in conjunction with its regular work, a large amount of reconnaissance survey of new country. The tour of the Agent to the Governor General to Eastern Toba and the Zhob Valley in July 1889 furnished an opportunity for extending our geographical knowledge in that direction, and 1,100 square miles of country were mapped there on the $\frac{1}{4}$-inch scale. In Western Baluchistan Sub-Surveyor Ahmad Ali executed a reconnaissance, resulting in the addition of 19,000 square miles of geographical information to our maps, and has completed all that is at present required to be known in that portion of Baluchistan: the report of this work has been separately printed. Another surveyor was deputed to Persia in March 1889 for survey work in association with officers employed under the Intelligence Branch of the Quarter Master General's Department. This undertaking was not completed at the close of the year under review, though a very large area of new country had been surveyed up to that time; this has not been included in the out-turn of work given below, but will be credited in next year's report.

30. The aggregate areas that have been geographically surveyed in the operations described above are as follows:—

19,000 square miles on the $\frac{1}{8}$-inch scale.
22,420 „ „ $\frac{1}{4}$-inch „

31. Exploration on the Northern Frontier of India has been limited to a reconnaissance by a native explorer in the neighbourhood of Sadiya, with a view to throwing some further light on the vexed question of the lower course of the Sangpo river between Pemakoi and its junction with the Brahmaputra, under the name of the Dihong river. The explorer was prevented by political difficulties from visiting those regions, and was forced to content himself with collecting information from native travellers and other sources, the result being, broadly speaking, that the course of the Dihong has been somewhat straightened out and made to flow in a more south-easterly direction (as opposed to southerly) than before. A large portion of the supposed drainage of the Zyul or Yang-sang-chhu has been now assigned to the Dihong river, thus giving an ostensible cause for the vast discharge of that stream, for which the previous disposition of the water-parting failed to account. Our knowledge of these regions is, however, ad-

mittedly very imperfect still, nor is there under present circumstances much prospect of improving it.

32. The report on explorations in Sikkim, Bhutan and Tibet, referred to in paragraph 32 of the last Administration Report, has been published.

HEAD-QUARTERS OFFICES.

33. The work done in the various offices at head-quarters is described in detail in Part III of this Report.

34. The number of new maps published during the year amounted to 3,820, of which 3,692 were cadastral maps. The total number of maps issued was 167,527, valued at ₹1,05,844. The cash sales of maps amounted to ₹9,424.

35. In the Drawing Office, the new map of Burma and Adjacent Countries, on the scale of 32 miles = 1 inch, embodying all the latest information, has been completed in a preliminary form in outline, and will shortly be ready in a more complete form, with the hill-ranges inserted upon it. The map of Upper Burma, on the scale of 16 miles = 1 inch, has been revised, and now shows approximate boundaries of divisions and districts: the series of sheets on the 8-mile scale, and the revision of the 4-mile sheets have made good progress. The new map of Afghanistan on the 24-mile scale, after having been delayed in order that new material furnished by the Quarter Master General's Department might be incorporated with it, is now completed.

Second editions of the maps of India, on the scales of 32 and 48 miles to the inch, have been completed during the year, and third editions are now in course of preparation, extended to the east and west so as to include the whole of Burma and Baluchistan.

36. The demands on this section of the office have increased enormously during the last few years, due (1) to the vast amount of trans-frontier work that has accrued since the Afghan war, (2) to the acquisition of Upper Burma, and (3) to the larger requirements of other departments for special maps: the establishment to cope with them has remained the same, and thus arrears are steadily accumulating, and without an increase to the establishment it is feared that the efficiency of the office to meet the demands made on it cannot be maintained.

37. The Photographic and Lithographic Offices, which hitherto have been scattered in three separate buildings, have now been concentrated in one house, which has been specially built by the Government for the purpose, and which was occupied during the year under report. A view of this building forms the frontispiece to this report. The whole of the offices forming the head-quarters of the Survey Department are now located in three contiguous buildings in Wood Street, by which arrangement greater efficiency and economy in supervision and administration will be obtained.

38. In the re-producing office the work done during the year has again been very large. The total number of copies of maps and other subjects of all kinds printed off was 1,203,181 and their value ₹1,69,628.

39. In the Lithographic Drawing and Printing sections the new edition of the 32-mile map of India in 6 sheets, which has so long been wanted, was completed and published. The provincial maps of Bengal and Assam, on the scale of 1 inch = 16 miles, have been re-published with additions and corrections. The bulk of the work done in these sections has been for other departments, and includes a new railway map, on the scale of 1 inch = 96 miles, for the illustration of the Administration Report of the Director-General of Railways; also a large number of statistical maps of Bengal and of the Punjab, on the scale of 1 inch = 80 miles, for the illustration of the Provincial Administration Reports. A chart in 6 sheets, on the scale of 1 inch = 32 miles, showing the telegraph lines in operation, has been prepared for the Telegraph Department, but not printed off. Several more of the series of military maps of country 10 miles round cantonments have been lithographed.

40. The departmental maps photozincographed include a new map of Burma and Adjacent Countries, in outline, on the 32-mile scale, and a 5th edition of the map of Upper Burma, on the 16-mile scale, both of which have been published: also plans of Baroda City and Deesa Cantonment and a new edition of the Simla Guide map, which was much required.

41. The heliogravure process has been making steady progress during the

year and was utilised for reproducing the plates for the Technical Art Series, and also some very delicate pencil drawings of insects required for the illustration of the Indian Museum notes. The lithographic and photographic work connected with the plates illustrating the volume of the Archæological Survey Reports edited by Dr. Burgess, C.I.E., containing Dr. Führer's "*Report on the Sharqi Architecture of Jaunpur*" has been completed; and so far as the plates are concerned, the volume as issued here will well stand comparison with those issued in England.

42. The removal of the offices into the new building has somewhat checked the development of new processes, but with the enormously improved accommodation now enjoyed therein, it is hoped that improved results will be obtained and progress be more easily made in new directions.

43. The demands on the Mathematical Instrument Office for survey and scientific instruments were less than in the previous year, when they were increased considerably by the requirements of the Railway and Public Works Departments in Upper Burma. The number issued on indent during the year under review was 36,500, valued at ₹2,07,621, which was about a mean between the value of the instruments issued in the last two years. During the same period 37,806 serviceable instruments, valued at ₹2,48,061, and 5,442 repairable instruments, valued at ₹54,387, were received into store, being very nearly equal in value to the receipts of the previous year.

44. In the Trigonometrical Branch Office, Dehra Dun, satisfactory progress has been made in the Computing section with the preparation of the two volumes embodying the final reduction of the principal triangulation in the Southern Trigon, which will be completed during the ensuing year. Another pamphlet of spirit-levelling operations, entitled No. 4, Madras Presidency, has been published. Solar photography has been carried on as usual with the two photo-heliographs, with the object of recording the spots and faculæ on the face of the sun, to supplement the series taken at Greenwich, and the results are included in the yearly volumes of the Greenwich observations.

ESTABLISHMENT.

45. In the Senior Division, during the year, the connection of no less than eight officers with the department has closed, which is twice the number that was expected.

Major-General C. T. Haig, R.E., Deputy Surveyor-General in charge of the Trigonometrical Branch, was superannuated on attaining the age of 55 years on the 12th October 1889, after a service of 30 years in the Survey Department. He was employed for 25 years on trigonometrical and topographical surveys in the Bombay Presidency, and in 1884 was appointed Deputy Surveyor-General, which appointment he held until the close of his service in the Department.

Colonel F. Coddington, S.C., Deputy Superintendent, 1st grade, was accidentally drowned in England on 28th April 1889, while on furlough. He had served for 27 years in the Survey Department, and had been employed throughout in the Revenue Branch.

Lieutenant-Colonel D. C. Andrew, S.C., Deputy Superintendent, 2nd grade, retired from the service on 26th March 1889, having been in the Revenue Branch of the Survey Department for over 26 years.

Colonel W. F. Badgley, S.C., retired from the service on the 28th June 1889, after employment in the Topographical Branch of the Department for 24 years.

Mr. H. Hörst, Deputy Superintendent, 3rd grade, was superannuated on attaining the age of 55 years, on 5th May 1889. He served in the Junior Division for 15 years, and in the Senior Division for nearly 20 years, and was employed throughout in the Topographical Branch.

Lieutenant-Colonel A. W. Baird, R.E., Deputy Superintendent, 3rd grade, was appointed to officiate as Master of the Calcutta Mint in May 1889, and was confirmed in that appointment in August 1889, when his connection with the Survey Department ceased. Colonel Baird entered the Department in December 1868, and since 1873 has been employed on scientific work connected with tidal operations on the Indian coasts, which he organised and carried out, and has rendered valuable service to science. In acknowledgment of the excellent work done by

him in this branch of science, he was awarded a medal of the 1st class at the Geographical Congress at Venice in 1881, and was elected Fellow of the Royal Society in 1885.

Colonel R. G. Woodthorpe, C.B., R.E., Deputy Superintendent, 4th grade, left the Survey Department on 15th February 1889, on obtaining the appointment of Deputy Quarter Master General, Intelligence Branch. He was appointed to the Topographical Branch of the Survey Department in 1871, and thus had been in it nearly 18 years, a considerable portion of which period was devoted to exploration surveys on the North-Eastern and North-Western Frontiers, with which his name has become associated as a distinguished and successful explorer.

Lieutenant W. H. Pollen, R.E., Assistant Superintendent, 1st grade, died on 26th March 1889, from fever contracted on field service with the Lushai expeditionary force.

46. In the Junior Division, seven surveyors and assistant surveyors have ceased to belong to the department by deaths and retirements. Of these the name of Mr. W. W. McNair, Surveyor, 3rd grade, who died from fever contracted at Quetta, is worthy of notice. Mr. McNair had been twenty-two years in the department, in which he distinguished himself as a geographical surveyor in Afghanistan and on the North-West Frontier. His main achievement, however, was his adventurous journey to Kafiristan in 1883, while on leave, which gained him the Murchison Grant of the Royal Geographical Society, and by which he has won a lasting name as an explorer.

47. The loss of the services of so many experienced officers at a time when there was no reserve of trained officers to fill their places, due to the cessation of appointments from 1885 to 1888 and the incomplete filling up of vacancies subsequently, has been the cause of great anxiety. The difficulty of providing qualified officers in this emergency to superintend the various field operations, which has been a subject of representation for the past five years, has been more than ever felt, and in some cases newly appointed officers have from necessity been placed in charge of responsible operations, which must suffer in consequence. The question of the recruitment of the department has been under the consideration of the Government of India during the past year, and it is hoped that orders may shortly issue to place the department on an adequate footing with the work that it is called upon to perform.

PART II.

THE OPERATIONS OF THE SEVERAL FIELD PARTIES.

TRIGONOMETRICAL SURVEYS.

PRINCIPAL AND SECONDARY TRIANGULATION.

BURMA.

No. 24 Party.

48. Since the submission of the last report the *locale* of the operations of this party has been transferred from the Eastern Coast of India to Burma; the staff was strengthened by two Assistant Surveyors, and the nature of the operations extended, so as to embrace the laying out of a principal series of triangulation on the meridian of 96° 30′, in addition to fixing beacons on the Burma Coast for the Marine Department. The orders conveying the sanction of Government for the new survey were received by Mr. Ryall in September and the members of the staff were ordered to assemble at Mussooree during the month of October.

Personnel.

Mr. E. C. Ryall, Assistant Superintendent, 1st grade, in charge up to 17th May 1889.
Captain S. G. Burrard, R.E., Deputy Superintendent, 4th grade, in charge from 11th June to 18th August 1889.
Mr. J. Eccles, M.A., Officiating Deputy Superintendent, 4th grade, in charge from 19th August 1889.
Mr. J. Hickie, Assistant Surveyor, 1st grade, in charge from 18th May to 10th June 1889.
Mr. J. Keating, Assistant Surveyor, 1st grade.
Mr. B. R. Hughes, Assistant Surveyor, 2nd grade.

49. It was intended that the observations should be taken with a 12-inch theodolite of a pattern new to the Indian Survey and recently constructed by Messrs. Troughton and Simms. As this instrument, which was only received at the end of October, carried only two microscopes for reading the limbs, it was determined by the Deputy Surveyor-General to have it tested before carrying out the work for which the instrument was intended. For this purpose the instrument was put up in one of the observatories at Dehra Dun, and some angles were measured with it: the results obtained were found to bear comparison with values of the same angles measured with the 24-inch and 36-inch theodolites. During the testing, a slight defect and one in no way interfering with the accuracy of its performance was brought to light, to remedy which the instrument had to be sent to the Mathematical Instrument Office, Calcutta. The delays caused by the late arrival of the instrument, its being tested at Dehra Dun, rectifying its defect and in obtaining part of the equipment at Calcutta, extended well into the season, so that it was the 24th November before the assistants with the native establishment could get away from Calcutta, Mr. Ryall leaving that port himself a week later in charge of the instrument. On arrival at Rangoon further delay was experienced by the non-arrival of stores despatched by steamer, the last of the boxes containing the heliotropes only coming to hand on about 15th December.

50. The programme arranged for the season was as follows:—

Mr. Hickie was to take up the approximate work of the new series on the meridian of 96° 30′, proceeding northwards from the side Mya-ya-beng-kyo to Theyekhu of the Eastern Frontier Series, with Mr. Hughes to help him, until such time as the services of the latter were required as Observatory Assistant. To Mr. Keating was allotted the fixing of beacons on the coast between Cape Negrais and Sandoway for the use of the Marine Survey Department, while the Executive Officer purposed taking up the final observations.

51. Mr. Ryall having ordered the assistants out on the work allotted to each, remained himself at Rangoon to make all the necessary arrangements with the local officers. The difficulty about transport being the most pressing, he tried to obtain elephants from the Commissariat Department, but all his efforts here, as elsewhere later on, were unsuccessful.

52. About the end of January the Executive Officer moved up to Kanyutkwin to meet Mr. Hickie, who had represented the difficulties he was

encountering. After seeing Mr. Hickie, the Executive Officer moved up to Toungoo for the purpose of meeting the Deputy Commissioner of that place. Having failed to procure locally any transport animals on hire, sanction was obtained for the purchase of animals, and four elephants and twelve ponies were bought for use in the party. About the end of February, owing to the very backward state of the work, the Deputy Surveyor-General proceeded to Burma to inspect Mr. Ryall's party, which was found to be in a very unsatisfactory state, and the result of the inspection was specially reported to the Government in letter No. 808S., dated March 21st, 1889. Mr. Ryall subsequently proceeded to Mya-ya-beng-kyo station for the purpose of observing an azimuth. The instrument was put up, but owing to clouds and to the haze which had then settled down, and which is characteristic of the country, it was found impossible to take any observations. The Executive Officer with Mr Hughes waited on the hill top up to the 15th April, but all attempts to observe were fruitless, and the party was consequently ordered to be withdrawn from the field. Thus no final work on the principal series was obtained and the out-turn consisted in the selection of five stations, forming two quadrilateral figures and a single triangle, and the clearing of the rays between them. Further particulars regarding this work will be found in the narrative report of the officer in charge at page i of the appendix.

53. Making every allowance for the difficulties in starting operations in a new and troublesome country, this failure must be attributed to want of zeal and management in the Executive Officer. On return of the party from Burma, Mr. Ryall was removed from the charge thereof and it was placed temporarily under Captain Burrard, R.E., who retained charge during the recess season. Mr. Eccles has been appointed to superintend it for the approaching season, when the party will continue the previous programme.

54. The operations on the coast for fixing beacons for the Marine Department were placed under Mr. Keating. Owing to the impenetrable jungle which covered the country, it was found that triangulation would be both extremely costly and slow, and it was therefore decided to run a traverse along the coast. This traverse emanated from the Great Trigonometrical Survey station Maw Ding, which is 6 miles south of Cape Negrais, and it has been carried northward over a distance of about 157 miles, closing on another trigonometrical station, Bowendong H. S. The positions of five suitable points for beacons were fixed, where artificial structures were raised, and fifty-three additional points were fixed which presented themselves as naturally conspicuous objects and fitted to answer the purposes of beacons. The country traversed was most rugged and difficult for survey operations. The angular work was checked by observations for azimuth taken at eleven stations, the average error being only one minute of arc in every fifteen angles, while the linear error was 1·7 feet per mile—results which are exceedingly good for this class of work, considering the nature of the country, and they reflect credit on Mr. Keating's zeal and abilities. Further details of the nature of the country and of the operations will be found in Mr. Keating's narrative report at page ii of the appendix.

TOPOGRAPHICAL SURVEYS.

GUJARAT AND SOUTHERN MARATHA COUNTRY, BOMBAY PRESIDENCY.

No. 10 Party.

55. Hitherto this party has been employed in two sections of equal strength, partly on topographical surveys and partly on forest surveys in the Bombay Presidency, the same system likewise prevailing in No. 17 Party; but, in consequence of the request made by the Government of Bombay, that one entire party should be placed at their disposal for employment exclusively on forest surveys, the forest section of No. 10 Party was transferred to No. 17 Party, and the topographical section of No. 17 Party transferred to No. 10 Party, so that

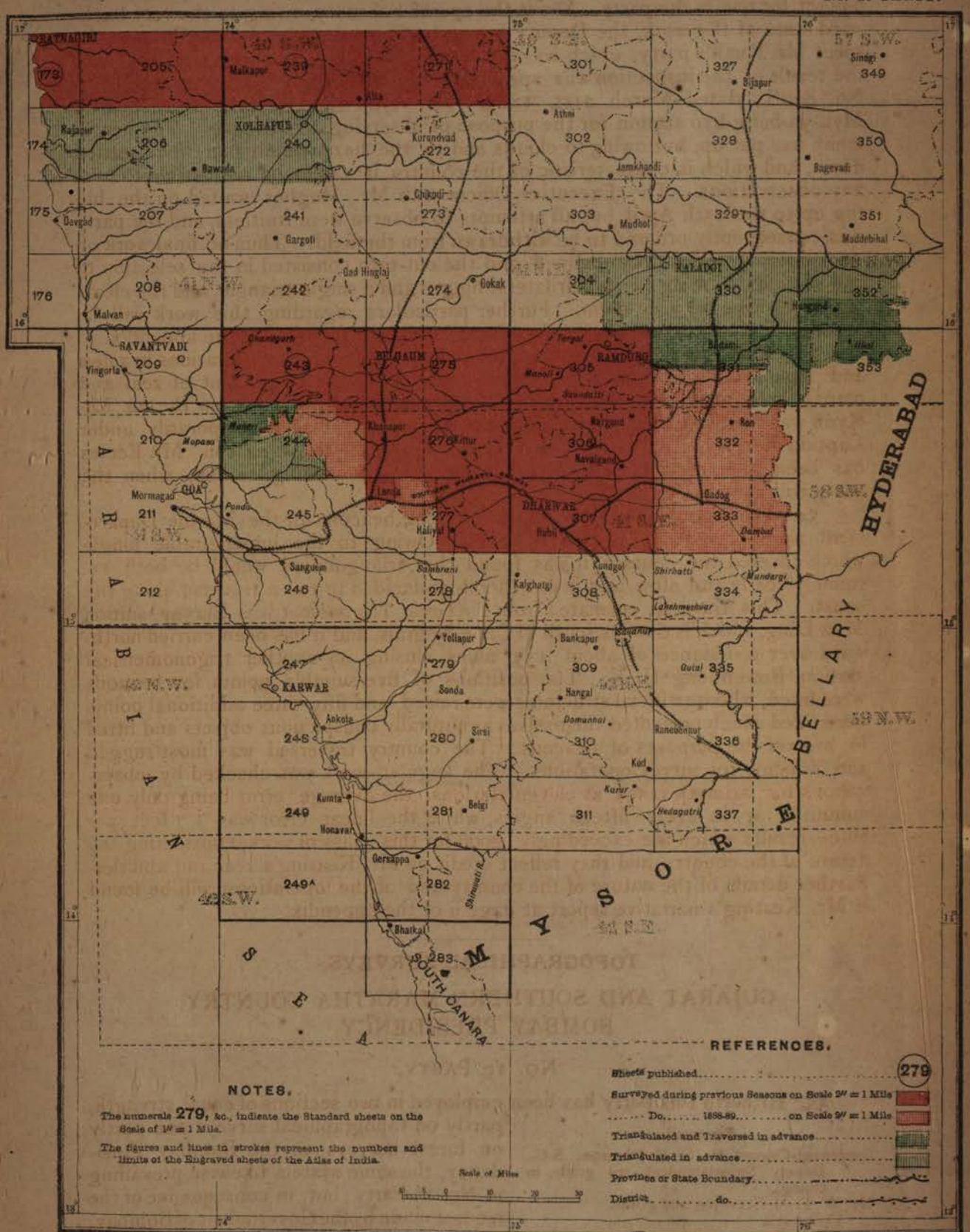
Personnel.

Lieutenant-Colonel H. S. Hutchinson, S.C., Deputy Superintendent, 3rd grade, in charge.
Mr. W. Todd, Surveyor, 2nd grade.
„ C. Tapsell, „ 4th „
„ G. D Cusson, Assistant Surveyor, 1st grade.
„ W. M. Kelly „ „ „
„ R. R. Dickinson, „ „ „
„ G. A. Knight, „ „ „
„ W. E. Adams, Assistant Surveyor, 3rd grade, from 26th August 1889.
33 sub-surveyors and others.

BOMBAY SURVEY.

INDEX TO THE BOMBAY TOPOGRAPHICAL SURVEY.

No. 10 PARTY.



NOTES.

The numerals **279**, &c., indicate the Standard sheets on the Scale of 1″ = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Atlas of India.

REFERENCES.

Sheets published ..... (279)

Surveyed during previous Seasons on Scale 2″ = 1 Mile

..... Do. ..... 1888-89 ..... on Scale 2″ = 1 Mile

Triangulated and Traversed in advance .....

Triangulated in advance .....

Province or State Boundary .....

District ..... do. .....

REFERENCE.	
New Numbers.	Old Numbers.
173	87
174	94
205	88
206	95
239	89
240	96
271	90

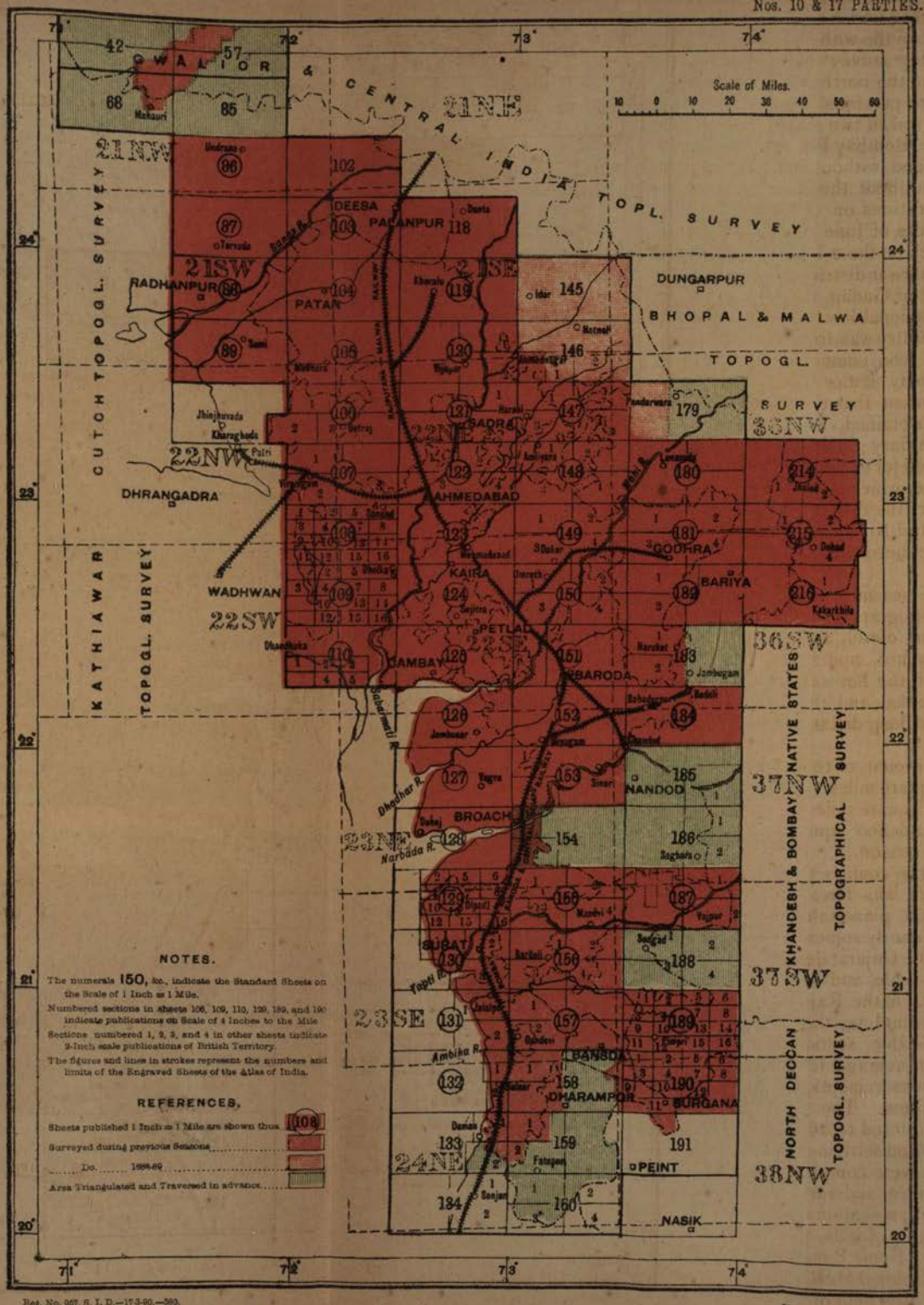
Reg. No. 957, S. I. D.—4-3-00—580.

Photo., S. I. O., Calcutta.

BOMBAY SURVEY.

INDEX TO THE SURVEY OPERATIONS IN GUJARAT.

Nos. 10 & 17 PARTIES.



NOTES.

The numerals 150, &c., indicate the Standard Sheets on the Scale of 1 Inch = 1 Mile.

Numbered sections in sheets 106, 109, 110, 129, 189, and 190 indicate publications on Scale of 4 Inches to the Mile

Sections numbered 1, 2, 3, and 4 in other sheets indicate 2-Inch scale publications of British Territory.

The figures and lines in strokes represent the numbers and limits of the Engraved Sheets of the Atlas of India.

REFERENCES.

Sheets published 1 Inch = 1 Mile are shown thus (108)

Surveyed during previous Seasons

Do. 1889-90

Area Triangulated and Traversed in advance

REFERENCES.

Old Numbers on Sheets	New Numbers on Index
70	86
71	87
72	88
73	89
74	102
75	103
76	104
77	105
78	106
79	107
80	108
81	109
82	110
3	118
4	119
5	120
6	121
7	122
8	123
9	124
10	125
11	126
12	127
13	128
14	129
15	130
16	131
17	132
18	133
19	134
23	145
24	146
25	147
26	148
27	149
28	150
29	151
30	152
31	153
32	154
33	155
34	156
35	157
36	158
37	159
38	160
39	179
40	180
41	181
42	182
43	183
44	184
45	185
46	186
47	187
48	188
49	189
50	190
51	191
52	214
53	215
54	216

Nos. 68 & 85 are 43 & 85 of Rajputana Survey.

Reg. No. 967, S. I. D.—17-3-90.—360.

Photo., S. I. O., Calcutta.

each party should be employed on one class of work. No. 10 Party has thus been engaged during the year under report solely on general topography.

56. Consequent on the withdrawal of No. 17 Party from topographical surveys, the area remaining for survey in Gujarat, as well as that of a small portion in Rajputana situated on the north-west border of it, were assigned to No. 10 Party, in addition to the area previously allotted to it in the Southern Maratha country. The party was organised in two sections to work respectively in the northern and southern tracts of the Bombay Presidency, so that the topographical surveys in progress should proceed without interruption. Lieutenant-Colonel Hutchinson retained charge throughout the year, and both sections left Poona for their respective field of operations on 10th November 1888, and returned to Poona for recess about the middle of June 1889.

57. Detail survey on the 2-inch scale, in the Southern Maratha country, was undertaken in the Dharwar district, in continuation of the previous season's work, in the neighbourhood of Gadag, where the country is mostly flat or only slightly undulating, with occasional low ranges of hills. The only difficulty experienced in this part of the country was from the conduct of the natives of a village in the Nizam's Dominions, who committed an unprovoked and serious assault on the small triangulation party under Mr. Dickenson. Due notice had been given to the Nizam's Government that the frontier would be surveyed, and sanction for the same had been obtained, but apparently no notice had been given to the villages near the boundary; and in this case it is supposed that the surveyor and his party were mistaken for excise officials, as there is no doubt that liquor was being distilled in the village, which was less than two miles from the British boundary, within which distance the distillation of liquor is prohibited according to a treaty between the British and Nizam's Governments. For this aggravated assault the two ringleaders have been sentenced to two years' imprisonment and a fine of ₹1,000 each.

58. Later in the season some portions of country along the ghâts, in sheets 244 and 277, were topographically surveyed; here the ground was hilly throughout, more intricate in detail, and covered with jungle. The country below the ghâts is low and very hot, and survey work is arduous; during the cold weather it is unhealthy and in the hot season exceedingly steamy and unpleasant. It is much cut up with creeks, and the foliage is thick and high, so that communications are difficult, and long distances can seldom be seen except from one hill-top to another.

59. The total amount of topography completed in the Southern Maratha country was 1,542 square miles. In addition to this, 1,950 square miles were triangulated and 2,000 square miles were traversed, of which an area of 600 square miles of the latter and 800 square miles of the former are in advance for the detail survey of next season.

60. In Gujarat the country surveyed formed part of the Idar State. Nearly the whole of this area was forest clad, making work by interpolation difficult; this necessitated much plane-table traversing and chaining, and the progress of the work was consequently somewhat slow. This is unavoidable in a country of this description. The Gujarat detachment completed 1,109 square miles of detail survey on the 2-inch scale, and the triangulation was extended over sheets 185, 186, and part of 154 in the Rajpipla State, embracing an area of 1,460 square miles, which nearly completes the portion remaining for survey in Gujarat.

61. Each plane-table section has been checked either by chain-traverses run across them of an average length of 7 or 8 miles, or, where the country did not admit of chain measurements, they were carefully examined *in situ* by one of the European assistants. The total length of the test lines in the Southern Maratha country amounted to 260, and in Gujarat to 125 miles.

62. The survey and settlement of the large tract of disputed country between Meywar and Marwar were completed this year. The operations extended over a length of about 67 miles, and varied in breadth from about 4 to 9 miles in and at the foot of the Aravalli mountains. The tract consisted almost entirely of rugged, densely-wooded ranges of hills, the highest peaks of which rose up to nearly 4,000 feet in height. Some 8 miles at the southern end of this disputed portion had been settled by Colonel McRae a few years ago, and during last year, 1887-88, Major Wyllie, with the help of a small detachment of surveyors from No. 17 Party, had continued the work, finishing the survey and settlement of 26 miles

at the northern end. During the present season the remaining 33 miles were surveyed and settled. It was also found necessary to re-survey the 8 miles settled by Colonel McRae, the traverse charts made by his *amins* not being of any value for the purpose of laying down the boundary on the 1-inch topographical maps. For this purpose a small detachment from this party, under Mr. G. D. Cusson, was deputed to the Rajputana Agency. Besides showing the whole boundary on the 1-inch standard sheet, 2-inch maps were prepared by enlargement with the pantagraph, which showed the claims made by the villages on either side of the boundary, and triplicate copies of these maps were supplied to the Political authorities. In addition to these, special surveys of those parts which were cultivated or were otherwise of value, were made on the 4-inch scale, and were used by the Boundary Settlement officer in deciding the disputes of those portions.

63. During the recess the fair drawing of sheets 333, 332, and of the two western sections of sheet 277 (the two eastern sections were drawn last year) was completed on the 2-inch scale for reduction to the 1-inch: the eastern half of sheet 244 was also mapped. These are in the Southern Maratha country. In Gujarat, sheets 145 and 146 have been drawn and are ready for publication.

64. The recess office of the party was inspected at Poona during July by the Surveyor-General, who was well satisfied with the character of the surveys that had been executed, and with the general efficiency of the party.*

BALUCHISTAN.

No. 15 Party.

65. In October 1888, No. 16 Party, the second of the two parties employed in Baluchistan, was broken up, some of its members being transferred to No. 15 Party and the remainder to various parties working in India: No. 15 is now the only party working in Baluchistan.

Personnel.

Lieutenant-Colonel T. H. Holdich, R.E., Deputy Superintendent, 2nd grade, in charge from 1st November 1888.
Lieutenant R. J. H. Mackenzie, R.E., Assistant Superintendent, 1st grade.
Mr. W. W. McNair, Surveyor, 3rd grade, up to 31st July, 1889.
Mr. T. E. M. Claudius, Surveyor, 3rd grade.
„ W. C. G. Barckley, Assistant Surveyor, 1st grade.
Mr. E. Graham, Assistant Surveyor, 1st grade.
Mr. G. P. Tate, Assistant Surveyor, 1st grade.
Rai Hira Singh Bahadur, Assistant Surveyor, 3rd grade.

Sub-Surveyors.

Imam Sharif, K.B., Ahmad Ali, Abdul Gaffar, Hussain Baksh, Sheik Mohidin, Asghar Ali and Jafar Ali.

66. Colonel Holdich took charge of this party from Captain Longe on the 1st November 1888, when the latter officer proceeded on furlough. The equipment and stock of both parties was at the same time transferred from Mussooree to Quetta, which station is now the head-quarters of the Baluchistan survey. An office and quarters for the European establishment have been specially built there for the accommodation of the party.

67. The party, of the strength shown above, has been engaged during the season on the following operations:—

1. Triangulation.
2. Topography on the 2-inch scale.
3. Ditto ½-inch scale (revision of previous surveys).
4. Geographical surveys on the ¼-inch and smaller scales.

The field work of the party comprised under heads 1, 2 and 3 was entirely within the limits of previous surveys and was carried on in country already well known and fully described in previous reports. That under head 4 consisted principally of a reconnaissance executed by Sub-Surveyor Ahmad Ali, in Western Baluchistan, and a report thereof has been separately printed and submitted to the Foreign Department. In bringing to notice the exceptionally good service rendered by Ahmad Ali while on this expedition, Colonel Holdich remarks that the work was effected at some risk to the sub-surveyor and in face of considerable difficulties. This reconnaissance has added 19,000 square miles

* Whilst reporting favourably of all the European assistants, Colonel Hutchinson more especially draws attention to the excellent services of Mr. C. Tapsell on the ordinary work of the party, and those of Mr. G. D. Cusson in connection with the survey of the Meywar-Marwar boundary.

of geographical information to our maps, and has, in fact, completed all that for the present we require to know of this portion of Baluchistan. A further area in this class of operations was obtained by Lieutenant Mackenzie, R.E., and Sub-Surveyor Imam Sharif, K.B., in Zhob and Eastern Toba, while accompanying Sir H. Prendergast during his tour in that district in July 1889. Assistant Surveyor Yusuf Sharif, K.B., was deputed to Persia in March 1889, on special duty in connection with the Intelligence Branch of the Quarter Master General's Department, and at the close of the year he had succeeded in mapping a very large area of previously unknown country: this work will form the subject of a special report.

68. The trigonometrical series of secondary triangles, which had been commenced during the previous season, *viz.*, from the Great Indus series near Dera Ghazi Khan to Quetta and the Kojak, was continued during the year by Mr. McNair, who recommenced from the point to which the series had previously been carried near Harnai, and by Christmas had observed at five more stations. All his stations were at a considerable altitude above sea and above the average plateau level. He was constantly subject to severe changes of climate and experienced much difficulty in arranging for supplies and water for his party. During the severest portion of the winter, between December and March, Mr. McNair carried on the computations at the Dehra office, and early in March he returned to field duty and completed the series as far as Quetta, leaving only four stations for future observation in order to carry it to the Kojak. Observations were taken at 13 stations, embracing an area of about 3,000 square miles over a direct distance of about 115 miles. While engaged in the computation of the season's work at Quetta, Mr. McNair contracted fever and was granted leave to proceed to Mussooree. After his arrival there, he grew rapidly worse and died on the 13th August 1889.

69. The minor triangulation, required for the extension of the 2-inch survey in the neighbourhood of Quetta and Peshin, was completed during the year. It lies entirely within the limits of previous $\frac{1}{2}$-inch surveys, on which it is based. The area triangulated amounted to 1,460 square miles, of which 300 square miles were done by Lieutenant Mackenzie, 250 by Mr. Claudius, 350 by Mr. Graham, and 560 by Mr. Tate. The change of scale for field mapping had rather disorganised the ordinary system of doing the triangulation a season in advance of the mapping, and the party was consequently obliged to have recourse to a system of triangulation and topography combined, which introduces field computation and leads to much subsequent revision in recess.

70. The area surveyed in detail on the 2-inch scale amounted to 988 square miles, and on the $\frac{1}{2}$-inch scale to 3,628 square miles. In addition to this, 1,100 square miles of country was surveyed by Lieutenant Mackenzie and Sub-Surveyor Imam Sharif, K.B., on the $\frac{1}{4}$-inch scale, in Zhob and Eastern Toba; some portion of this country had, however, been previously gone over and surveyed. Sub-Surveyor Ahmad Ali's tour through Western Baluchistan resulted in the large area of 19,000 square miles mapped on the $\frac{1}{8}$-inch scale.

71. The work of the party for the year may be thus summed up:—

The 2-inch military survey is very nearly completed, so far as the field work, triangulation and topography, is concerned. It is comprised in 24 sheets, of which seven only have been previously published as complete sheets. Two more have been sent in this season, making a total of nine completed sheets and leaving fifteen still in hand. Of the $\frac{1}{2}$-inch sheets, five have been sent in either as first material or partial revisions, and one revised sheet (the Bolan).

The re-drawing of five of the trans-frontier sheets has been rendered necessary by the new material furnished by Sub-Surveyor Ahmad Ali: these have been drawn on the new system for printing in two colours with vertical hill-shading. In addition to this, material for the correction of three sheets resulting from the reconnaissance surveys of Lieutenant Mackenzie and Sub-Surveyors Imam Sharif, K.B., and Sheik Mohidin, have been furnished to the Dehra drawing office. All geographical material has thus so far been utilised, leaving arrears only on the 2-inch scale of mapping. These arrears are, however, heavy, and special arrangements will be necessary to meet them.

72. Three soldier surveyors were attached to the party for instruction and rejoined their regiments at the close of the field season. They are all well reported on, and two of them were selected to accompany Sub-Surveyor Ahmad Ali in his tour through Western Baluchistan.

73. In reference to the lamented death of Mr. McNair, the following brief sketch of his official career was published in the monthly "Notes" of the Survey Department for August 1889:—

"Mr. McNair joined the Department on 1st September 1867, and was posted to the Rajputana Topographical Party. The first twelve years of his service were passed on topographical duty with this party under Major G. Strahan, R.E., and in the Mysore Party under Majors G. Strahan and H. R. Thuillier, R.E. From the very first he showed special aptitude as a plane-tabler and was soon recognised in the Department as an accomplished surveyor. In the autumn of 1879, he was selected to accompany the Khyber column of the Afghan Field Force and was present with that force during the severe fighting that occurred before Kabul in the winter of 1879-80, and the subsequent defence of Sherpur. Whilst in Afghanistan he mapped a very large portion of hitherto unknown country, including the Lughman Valley and approaches to Kafiristan and the Logar and Wardak Valleys to the south of Kabul. He explored the Adrak Badrak Pass with a native escort, and made himself acquainted with the route from Kabul to Jalalabad, *vid* Lughman, which was explored by no other European officer. At the close of the war, he was attached to the Kohat Survey under Major Holdich, R.E., and was specially employed in the risky work of mapping the frontier line from Kohat to Bannu, including a wide strip of trans-frontier country, and much of the hitherto unmapped Tochi Valley. On the break-up of the Kohat survey he was temporarily employed on geodetic work in one of the astronomical parties, but was re-transferred to the frontier when the Baluchistan parties were formed. His chief work in connection with Baluchistan has been carrying a first-class series of triangles from the Indus at Dera Ghazi Khan to Quetta, which occupied him to the close of his career. His ability as an observer, his readiness of resource under unusual difficulties, and his power of attaching the frontier people to him personally have been just as conspicuous throughout this duty as were his energy and success as a geographical topographer. Apart from his departmental career, he has won a lasting name as an explorer by his adventurous journey to Kafiristan, in 1883, when on leave. It may be fairly claimed for him that he was the first European officer who set his foot in that impracticable country, and he is still the best authority on many of the routes leading to it. His services to geographical science were recognised by the Royal Geographical Society, who awarded him the Murchison grant, and there can be little doubt that a distinguished career was still before him when he was suddenly cut off in the prime of his life."*

HIMALAYAS, PUNJAB.

No. 18 Party.

74. Field-work was resumed during November 1888, under the superintendence of Colonel Tanner, in Kángra, Kullu and the Simla Hill States, and was carried on till the rains commenced in the beginning of July 1889.

Personnel.

Colonel H. C. B. Tanner, S.C., Officiating Deputy Superintendent, 1st Grade, in charge.
Lieutenant W. J. Bythell, R.E., Assistant Superintendent, 2nd Grade, from 1st July 1889.
Mr. C. D. Potter, Surveyor, 4th Grade.
„ W. Robert, Assistant Surveyor, 1st Grade.
„ W. A. Fielding, ditto ditto.
„ P. F. Prunty, ditto ditto.

Sub-Surveyors.

Shah Nasiruddin, Rinzin Nimgyal, Wahid Ali Khan, and 20 others.

75. The several operations on which the party was engaged are the same as those noted in the last Annual Report, *viz*:—

(1) A topographical survey of the Kángra district, the hill portions of the Umballa and Gurdaspur districts and of the hill states about Simla, comprising both British and feudatory tracts. The scale adopted for the former, except in very high mountainous regions, is 4 inches

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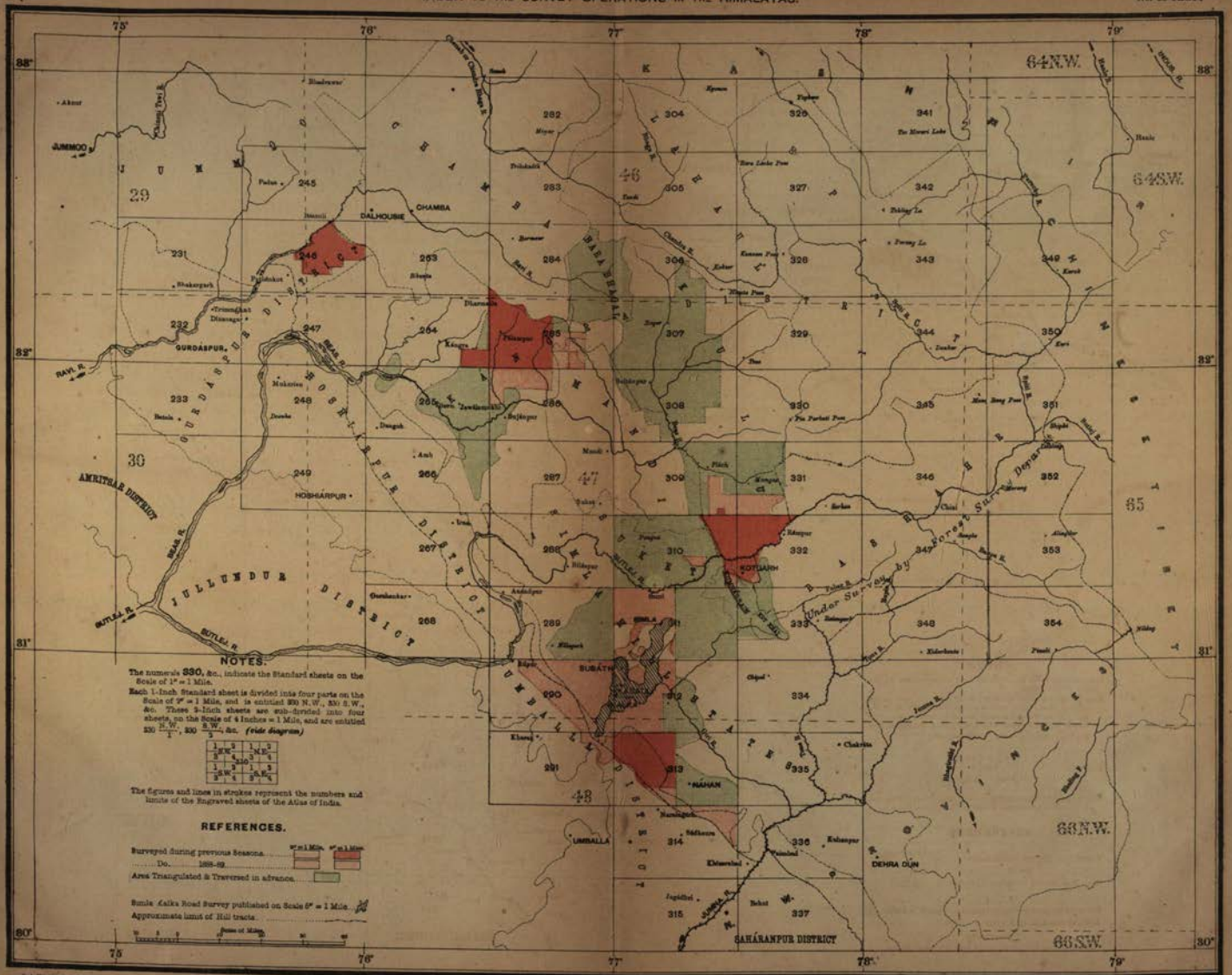
* Of his assistants, Colonel Holdich reports as follows:—
"Lieutenant Mackenzie's technical experience as a R. E. officer enabled him rapidly to acquire an accurate knowledge of our topographical system, though he still wants practice as a draftsman, and he proved himself a most able assistant in the work of office superintendence"
The work of all the European assistants and sub-surveyors is favourably reported on.

PUNJAB SURVEY.

INDEX TO THE SURVEY OPERATIONS IN THE HIMALAYAS.

No. 18 PARTY



NOTES.

The numerals **330**, &c., indicate the Standard sheets on the Scale of 1" = 1 Mile.

Each 1-Inch Standard sheet is divided into four parts on the Scale of 2" = 1 Mile, and is entitled 330 N.W., 330 S.W., &c. These 2-Inch sheets are sub-divided into four sheets, on the Scale of 4 Inches = 1 Mile, and are entitled 330 $\frac{N.W.}{1}$, 330 $\frac{S.W.}{2}$, &c. *(vide diagram)*

1	2	1	2
3	4	3	4
330			
1	2	1	2
3	4	3	4

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Atlas of India.

REFERENCES.

Surveyed during previous Seasons ..... 2" = 1 Mile. 4" = 1 Mile.

Do. 1888-89 .....

Area Triangulated & Traversed in advance .....

Simla Kalka Road Survey published on Scale 6" = 1 Mile.

Approximate limit of Hill tracts .....

Scale of Miles

Reg. No. 1911. S. I. D.—17-5-40—200.

Photo., S. I. O., Calcutta.

= 1 mile, in which, however, the topographical features to be depicted are confined to the details sufficient for a map on the 2-inch scale: this survey may, therefore, be classed as an exaggerated 2-inch survey. The scale for the native feudatory states is fixed at 2 inches to a mile; while the very high mountainous regions, both British and native, will be surveyed on the 1-inch scale.

(2) Traverse operations to fix the tri-junctions of *mauza** and *tikka* boundaries, and other permanent objects therein, so as to afford a suitable basis for the construction of the settlement maps of the British districts by local agency.

(3) The preparation of plots of the above traverse points intended for use as *patwári* field maps.

(4) The survey of forest boundaries.

(5) The drawing of the fair topographical maps.

76. The system of instructing soldiers of the native army has been continued and four men have been undergoing a course of training in the use of the theodolite, plane table, compass and perambulator, and are shortly to be taught the rudiments of practical astronomy. They have all made good progress and are well reported on by Colonel Tanner, with the exception of one, whose conduct necessitated his being transferred to another party.

77. The areas which have been topographically surveyed in the different localities are as follows:—

Locality.	Scale.	Area, Square miles.
District Kángra	4 inches = 1 mile .	210
Mandi State	,, = 1 ,, .	5
Simla Hill States	2 inches = 1 ,, .	358
	TOTAL .	573

The triangulation for 4-inch topography has been extended over 186 square miles, and for 2-inch work over 820 square miles.

78. Traverse operations for the Settlement department were carried on in Kángra and in the more level parts of the Kullu valley, and covered an area of 228 square miles. The traversing was executed by the bar-subtense method, which has been described in previous reports and continues to give very satisfactory results, the errors being so small that when plotted on the large scale of 56·7 inches to a mile, they are barely appreciable. These traverses have been plotted in 400 sheets, those in Kángra comprising 326 sheets on the scale of 27·7 inches = 1 mile, and those in Kullu in 74 sheets on the scale of 56·737 inches = 1 mile.

79. In Kullu it was arranged, in conjunction with the Forest Department under the orders of Mr. Diack, the Assistant Commissioner, to lay down on the maps of this party the positions of substantial distinguishing marks here and there along the forest boundaries. The actual work of building these marks devolved on the Forest Department, the positions being selected by the Survey officer. They are of a far more durable character than the usual forest cairns and will form points of departure on which any future rectification of the forest boundaries may be made; moreover, they will enable the existing forest boundaries to be relaid should they become erased between the distinguishing marks. The maps of Kullu of the past two seasons are awaiting the insertion of distinguishing marks which the Forest Department are now erecting.

80. In an area of 358 square miles of hill states surveyed, 10 forest blocks, with an area of 2·3 square miles, were mapped: the blocks had distinguishing marks at the prominent angles. Since this survey was made, other blocks have been demarcated and are reported ready for measurement, but it has not yet been decided if the party is to go back over the same ground again and determine their limits on the furnished maps.

81. The chief difficulty that Colonel Tanner has had to contend with is the insertion of names on the maps. In some localities the Civil officers have sup-

* A *mauza* includes an area within convenient and generally natural limits, and all the habitations therein; a *tikka* is a subdivision of a *mauza*.

plied reliable lists of names, but in others it has been necessary to fall back on the lists obtained by the sub-surveyors from local information. In one part of Mandi State, out of 40 names supplied from the office of the Commissioner of the Jullundur Division, only three on Colonel Tanner's lists could be identified with them. This shows that the sub-surveyor's lists must be accepted with caution. The authority for all the names found on the sheets is given in the references.

82. The traversing of the party is nearly completed and the remainder will be contained on some 40 sheets, scale 56·737 inches = 1 mile. The four hundred sheets comprising the present season's out-turn have been sent to the Deputy Commissioner of Kángra and Assistant Commissioner, Kullu.

83. The demarcation of the *tikka* trijunctions in Kángra and Kullu was found during the past season to be in a most complete and satisfactory state, and except in a part of Nádaun, the traverse surveyors had no difficulty in picking up these obligatory points.

84. The recess office of the party was inspected during September by the Deputy Surveyor-General in charge Trigonometrical Branch, who reports that he found arrears of trans-frontier exploration work which had accumulated owing to the Executive Officer holding a dual charge, *viz.*, that of the regular topographical surveys which have been reported on above, and of the exploration work on the North-East frontier, which consists chiefly of triangulation to snowy peaks (the reduction of the observations being somewhat laborious owing to difficulties of identification) and the adjustment and compilation of topography based thereon. Arrangements have now been made for clearing off these arrears by the early part of the next recess season.

85. The programme for the approaching field season has been arranged with a view of getting the party more together when in the field and preventing the execution of small pieces of detached work, which so greatly retards progress.*

FOREST SURVEYS.

CENTRAL PROVINCES.

No. 14 PARTY.

86. Mr. L. Pocock, Surveyor, 3rd grade, was in charge of this party at the beginning of the year, but was relieved by Colonel Wilmer on that officer's return from furlough on the 22nd October 1888.

Personnel.

Colonel J. R. Wilmer, S.C., Deputy Superintendent, 3rd grade, in charge.
Mr. L. Pocock, Surveyor, 3rd grade, in charge up to 22nd October 1888.
„ A. Christie, do. do.
„ D. Campbell, Assistant Surveyor, 1st grade.
„ F. E. Warde, do. do., 3rd do.

Sub-Surveyors, &c.

Azim Khan, Prem Raj, Golam Mahomed, Mahomed Zikeria, Gurdutt Singh, and 9 others.
25 temporary sub-surveyors and computers.

Military Students.

Havildar Hira Singh, 15th Sikhs.
Naik Kulnar Singh, 5th Goorkhas.
Lance Duffadar Pooran Singh, 12th Bengal Cavalry.
Sowar Sultan Surkhru, 3rd Punjab Cavalry.

87. The party has been employed, in continuation of the previous year's work, on the survey of forest reserves in the Hoshangabad and Betúl districts. The survey is on the scale of 4 inches to a mile and includes first and second class reserves, including protected and unprotected areas, but omitting all *málguzári*† lands.

88. The strength of the party on taking the field is given above; 21 of the subordinate staff were quite new hands and had never been in the field. This arose from the necessity of re-organizing the establishment to suit the change in the character of the survey on which this party had been hitherto employed.

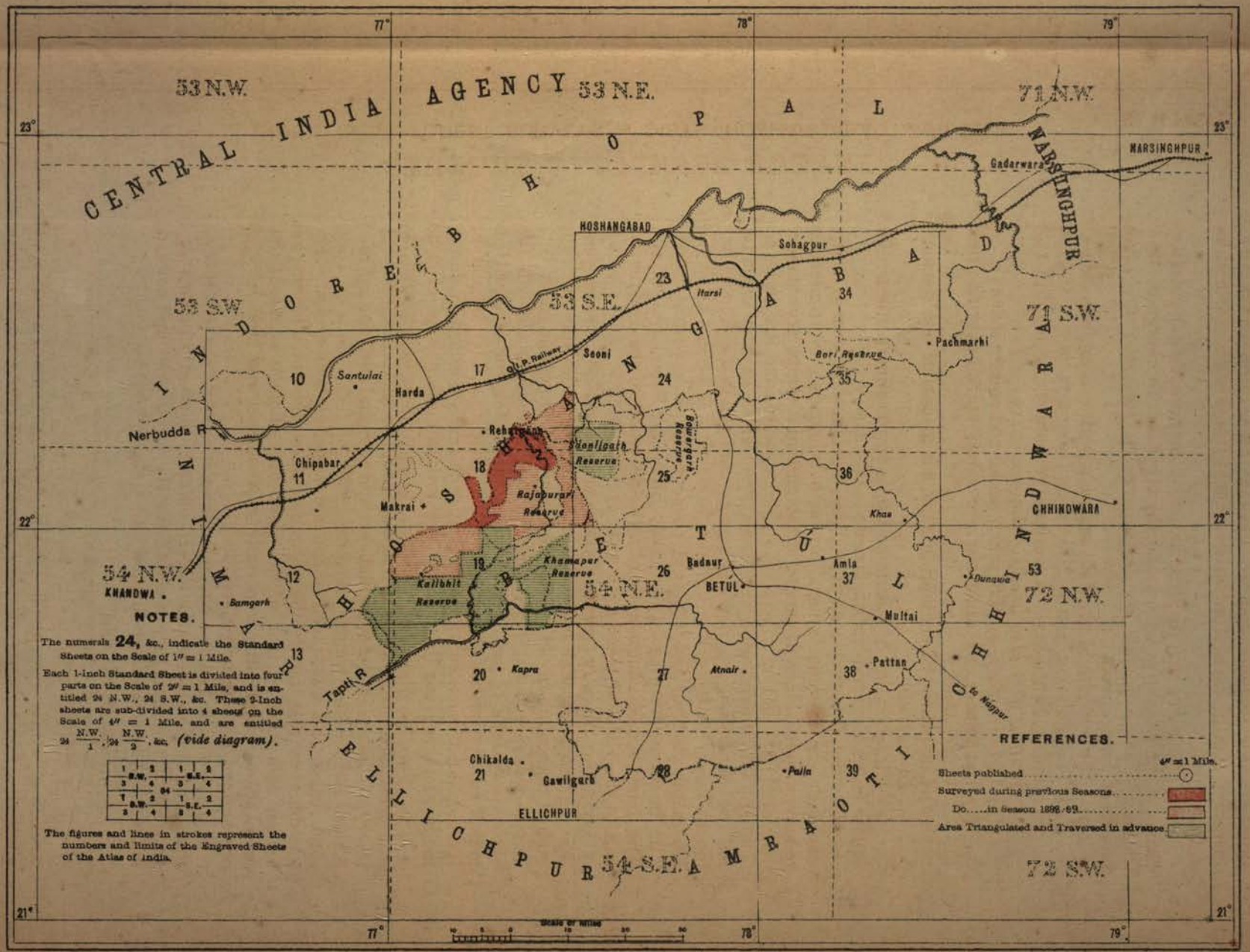
* Colonel Tanner reports very favourably of his European Assistants, Messrs. Potter, Robert, Fielding and Prunty; he also reports well of Sub-Surveyors Shah Nasiruddin, Rinzin Nimgyal, Wahid Ali Khan and several others, and adds "the whole of the assistants are entitled to my thanks for the manner in which they have conducted their duties in the face of considerable physical difficulties."

† This term signifies land paying revenue to Government, in contradistinction to *Jagirs*.

CENTRAL PROVINCES SURVEY.

INDEX TO THE FOREST SURVEYS IN DISTS. HOSHANGABAD AND BETUL.

No. 14 PARTY.



NOTES.

The numerals **24**, &c., indicate the Standard Sheets on the Scale of 1″ = 1 Mile.

Each 1-inch Standard Sheet is divided into four parts on the Scale of 2″ = 1 Mile, and is entitled 24 N.W., 24 S.W., &c. These 2-inch sheets are sub-divided into 4 sheets on the Scale of 4″ = 1 Mile, and are entitled $24\ \frac{N.W.}{1}$, $24\ \frac{N.W.}{2}$, &c. *(vide diagram).*

The figures and lines in strokes represent the numbers and limits of the Engraved Sheets of the Atlas of India.

REFERENCES.

4″ = 1 Mile.

Sheets published ⊙

Surveyed during previous Seasons

Do. ..in Season 1892-93

Area Triangulated and Traversed in advance

Reg. No. 038, S. I. D.—173-93.—560.

Photo., S. I. O., Calcutta.

89. Owing to the unhealthiness of the tracts in which the survey operations had to be carried on, it was found necessary to postpone the departure of the party into the field until the 20th December. The establishment assembled at Harda at the end of that month and the survey work was commenced about 15th January 1889. The field work was continued until 10th May, when, owing to the want of water, the party had to withdraw. Thus the period during which field operations can be carried on in these forest tracts is limited to about four months in the year.

90. The party was divided into five sections, the head-quarters being in charge of the Executive Officer and the other four in charge of Messrs. Pocock, Christie, Campbell, and Warde; supervising squads of 11, 10, 9 and 7 sub-surveyors, respectively.

91. The out-turn of the field season's work was as follows :—

(*a*) Triangulation, 402 square miles, fixing 473 points (including stations) and 444 heights. A very large number of heights to facilitate contouring were also fixed by clinometer ;

(*b*) Detail survey, on the 4-inch scale, 308 square miles ;

(*c*) Linear miles of traversing 272 miles, spread over an area of about 349 square miles ;

(*d*) Completion of contouring work left in outline last season of 36 square miles ; and

(*e*) Classification of forests and soils of 390 square miles. This includes 81 square miles surveyed but unclassified last year.

The detail survey was tested by the officer in charge and the assistants who daily visited some one or other of their squads. No serious errors involving re-survey were detected, except in the case of a temporary sub-surveyor who was dismissed ; and of one sub-surveyor whose contouring had to be redone.

92. The triangulation was based upon sides of that executed in 1865-66 for the one-inch topographical survey and which required to be supplemented for the larger scale work now in progress. It was carried on in the Kalibhit and Khámapúr reserves and in part of a second class reserve in standard sheet No. 17. The traverses were generally taken along the boundaries, fire-lines and roads. The detail survey completed embraces the whole of the Rájaburári reserve and part of the Kalibhit reserve.

93. The country surveyed was almost entirely forest jungle, including heavy grass lands, with insignificant patches of cultivation here and there. The ground was more or less hilly everywhere. Only one river of any size, the Ganjál, was met with ; this contains water in some places all the year round, but in the forest it generally dries up soon after the end of April, and even in the middle of that month water is hard to procure. The inhabitants are chiefly Korkus and Gonds, and local assistance is scarce, especially during March, when the inhabitants leave the place to get work in cutting crops elsewhere.

94. On the whole the health of the party was better than last year, owing in a great measure to good management and to the precautions taken to prevent fever, *viz.*, issue of quinine, blankets and tea, and insisting on the men drinking boiled and filtered water. Several cases of fever, however, occurred, and in some cases this was traced to bad water having been drunk. The climate also was different from that of the previous season, the rainfall being very slight this season compared to that of the last. But there is no doubt that these forest tracts are very unhealthy, especially in November and December, and the above precautions are very necessary.

95. Colonel Wilmer has, in conjunction with the Chief Commissioner of the Central Provinces and Forest officers, devised a means of utilising the services of the surveyors in classifying the forest trees and soils in the following manner. The forests are divided into 5 classes, *viz.*—

1 Teak without Bamboo,	4 Grass,
2 Teak and Bamboo mixed,	5 Cultivation,
3 Miscellaneous,	

to each of which (except the 4th which was left white) a distinctive *colour* was allotted. The soils were divided into 4 classes, *viz* :—

1 Good,	3 Dry,
2 Medium,	4 Unproductive,

to each of which a distinctive kind of *line-shading* was appropriated. Horizontal lines represent the first class, vertical the second, diagonal from right to left the third, and diagonal from left to right the fourth. These shading lines being drawn on tracing cloth in the colour appropriated to the particular class of forest found in each soil, an index to both trees and soil is furnished in a very readable form and with the expenditure of but little labour. Colonel Wilmer reports that the method has met with great approval from the Forest officers.

96. Four soldier students were attached to the party for training. They have learnt the use of the theodolite for taking observations of time and latitude; of the sextant and artificial horizon, and of boiling-point thermometers, besides plane-tabling on the 4-inch scale.

97. The recess quarters of the party were at Mussooree, where the office was inspected by the Deputy Surveyor-General of the Trigonometrical Branch in September.

The fair mapping and chart of the triangulation of the field season's operations in Hoshangabad have been completed and comprise 20 standard-sized sections on the 4-inch scale in sheets Nos. 17,18,19 and 25, which have been drawn for reproduction. The arrears of work of the previous survey in the Mirzapur district left by Colonel Wilmer's predecessor have been nearly cleared off. The mapping is completely finished, and there only remains the general report on the triangulation and traversing, which is in an advanced state, and will probably be submitted early next recess.

98. The programme for the ensuing season includes the survey of the Kalibhit and Khámápur reserves, the triangulation of the Sáonligarh, Bowergarh, and Khámápur reserves, and of some detached portions of second class forest in the extreme west of the Hoshangabad district, as well as the traversing of boundaries in the same areas.*

BOMBAY PRESIDENCY.

No. 17 Party.

99. Colonel Pullan has been in charge of the party throughout the year. The operations upon which it has been engaged have been confined to forest tracts, and are as follows:—

Personnel.

Colonel A. Pullan, B.S.C., Deputy Superintendent, 2nd grade, in charge.
Mr. A. M. Lawson, Surveyor, 2nd grade.
„ S. F. Norman, Assistant Surveyor, 1st grade.
„ C. A. Norman, Assistant Surveyor, 1st grade.
„ P. J. Serrao, Assistant Surveyor, 2nd grade, up to 1st March 1889.

Sub-Surveyors.

Gopal Vishnu, G. R. Bhopatkar, Govind Gopal, Ram Chandra Joshi, Ganesh Narayan, Vasudeo Ganesh Bhat, and 20 others.

(i) The survey on the 4-inch scale of forest reserves in the *talukas* of Wái and Jaoli, Satara district; of Málegaon and Yeola, Nasik district; of Mával and Khed, Poona district; and of Haliyál or Supa, North Kanara district.

(ii) The survey on the 8 inch scale of forest reserves in the Karjat *taluka*, Thana district.

(iii) Triangulation and traversing in Karjat *taluka*, Thana district.

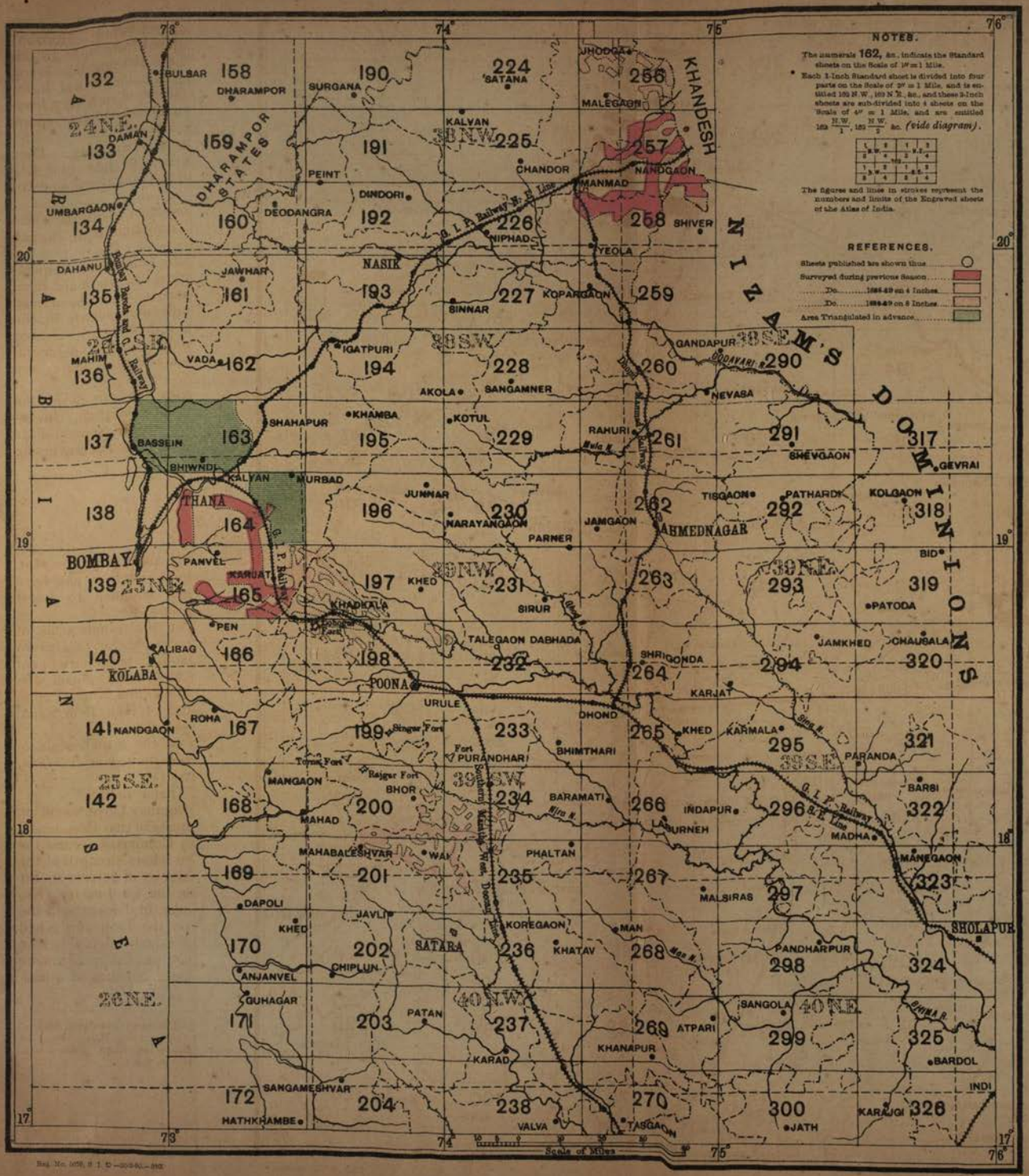
100. The party was placed at the disposal of the Bombay Government on the 1st October 1888, for employment on the survey of forests in that Presidency. It was originally decided, in consultation with the Survey Commissioner and the Conservator of Forests, Northern Circle, to employ the whole strength of the party during the season under review on the 4-inch surveys of forests in the Satara, Nasik, Poona, and North Kanara districts, but on the 1st January 1889 Colonel Pullan was requested by the Survey Commissioner, in deference to the wish of the Conservator of Forests, to stop the work on the Jaoli and Khed *talukas*, in order to furnish a detachment to undertake 8-inch survey in the Thana district during the current season. This change in the programme during the season's operations resulted in a somewhat lower out-turn of 4-inch work than was at first expected.

* Colonel Wilmer reports very favourably on the work of all his European assistants, Messrs. Pocock, Christie, Campbell and Warde, especially of the first; and also on the following sub-surveyors:—Premraj, Mohamed Zikeria, Gurdut Singh, Hyder Ali, Kadir Sharif, Karimdad Khan, Sutto Charn Ghosal, Surjan Singh and Abbas Ali, and also the head writer, Syed Zille Hosnain.

BOMBAY FOREST SURVEY.

INDEX TO THE SURVEY OPERATIONS IN THE NORTHERN DIVISION.

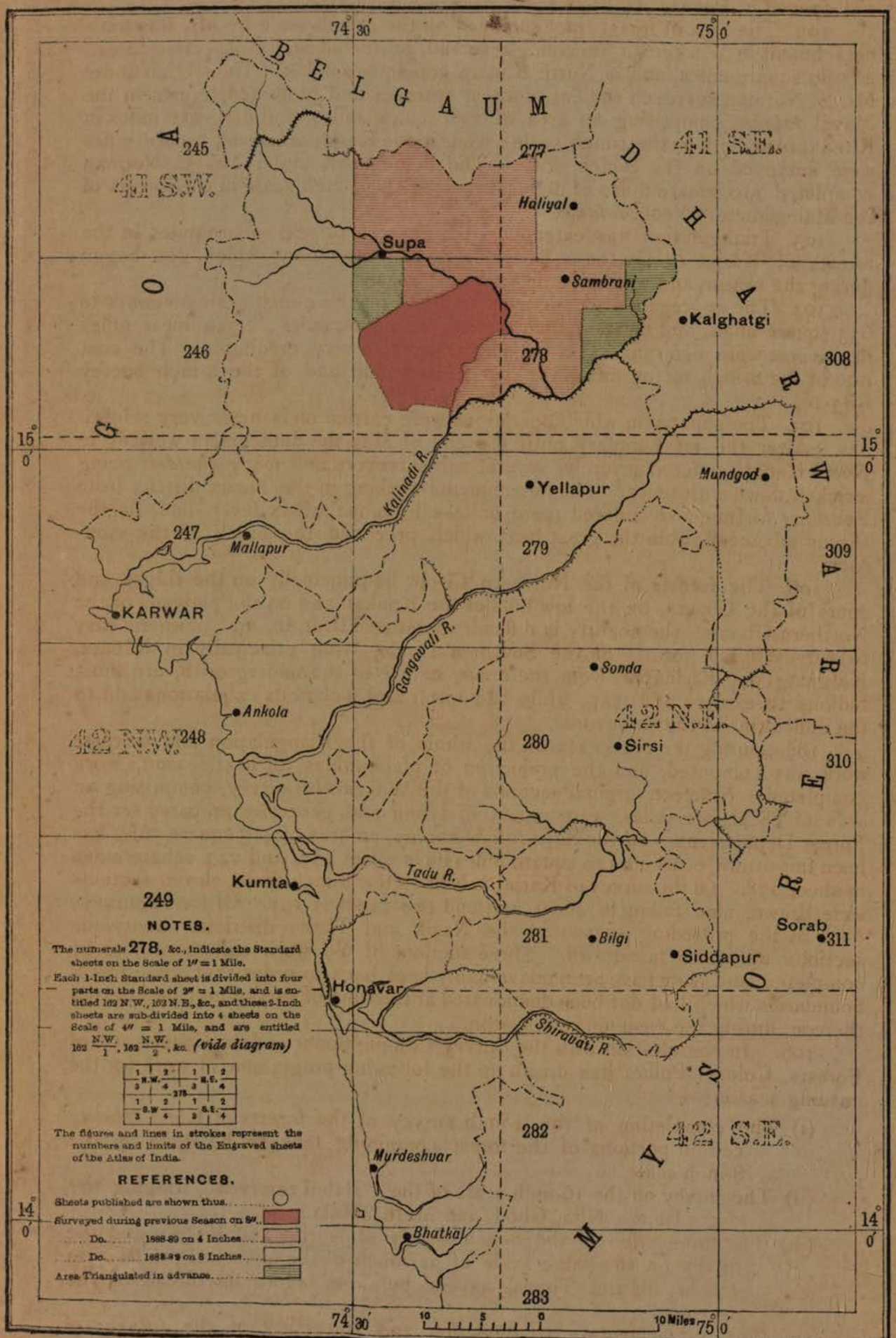
No. 17 PARTY.



BOMBAY SURVEY.

INDEX TO THE FOREST SURVEY IN N. KANARA (S. CIRCLE).

No. 17 PARTY.



NOTES.

The numerals **278,** &c., indicate the Standard sheets on the Scale of 1″ = 1 Mile.

Each 1-Inch Standard sheet is divided into four parts on the Scale of 2″ = 1 Mile, and is entitled 162 N.W., 162 N.E., &c., and these 2-Inch sheets are sub-divided into 4 sheets on the Scale of 4″ = 1 Mile, and are entitled 162 $\frac{\text{N.W.}}{1}$, 162 $\frac{\text{N.W.}}{2}$, &c. *(vide diagram)*

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Atlas of India.

REFERENCES.

Sheets published are shown thus.....

Surveyed during previous Season on 8″.....

.....Do..... 1888-89 on 4 Inches.....

.....Do..... 1888-89 on 8 Inches.....

Area Triangulated in advance.....

Reg. No. 1036, S. I. D.—13-1-90.—550.

Photo., S. I. O., Calcutta.

101. The party was divided into three detachments, in charge of Messrs. Lawson, S. Norman, and C. Norman respectively. Field-work was commenced early in November 1888 and ceased on the 8th June 1889, when the recess office was opened at Poona.

102. The area of forest tract surveyed on the 4-inch scale by Mr. Lawson's detachment in Wái *taluka*, including reserved, protected and prospective forest, was 89 square miles, and in North Kanara 300 square miles. The section under Mr. S. Norman surveyed the entire forest reserves and protected forests in the Mával *taluka*, comprising an area of 128 square miles, and 6 square miles in Khed *taluka*, both on the 4-inch scale: while in the Karjat *taluka* 22 square miles were surveyed on the 8-inch scale. The detachment under Mr. C. Norman completed 110 square miles of detail survey on the 4-inch scale in the forests of the Málegaon and Yeola *talukas*.

103. Triangulation was extended over an area of 386 square miles in the forests of Karjat *taluka*, as a basis for the 8-inch survey, which was begun during the season and will be completed next season.

104. The aggregate area surveyed in detail on the 4-inch scale amounts to 633 square miles, and on the 8-inch scale to 22 square miles; 1,349 linear miles of traverse were also run. This out-turn of work is very creditable. The cost rate of the 8-inch survey was ₹182 per square mile and of the 4-inch survey ₹83-10.

105. The country in which operations were carried on is never very salubrious. After the 1st February until the end of May the detachment working in North Kanara suffered severely, several sub-surveyors and many *khalásis* being stricken down with fever. The detachments working in the Thana district from February to June also suffered more or less from malarious fever, and, as the season advanced, from the great heat which preceded the break of the monsoon.

106. The forests of the Northern Circle lie principally on the ridges and spurs of the Ghauts, on the low hills of the Konkan and on the plateaus of the Northern Ghauts: the country is difficult to move about in, and nowhere easy to survey. The forests of the Southern Circle, lying principally in Kanara, Kalghatgi and Khánápur, from the dense nature of the undergrowth, are most tedious to explore and map, while bad water and malarious exhalations add to the difficulties of the surveyors.

107. During the recess season the whole of the triangulation and traverse work was computed, and the projection of plane-tables for next season's work completed. Nineteen original sections of the Wái *taluka* survey, comprising an area of 88 square miles, were mounted, typed and generally prepared for the Forest Department. Of the Supa *taluka* survey, an area of 413 square miles has been fair-drawn, of which 170 square miles lie in sheet 277, and 243 square miles in sheet 278. Of the survey of Karjat *taluka* on the 8-inch scale, eleven sections were drawn, nine falling in sheet 165 and two in sheet 197. Of forest surveys done in the preceding season in the Nasik and Thana districts, twenty-one sections were also fair-drawn. Three sections of old work still remain to be completed and they have been unavoidably kept back in order that some forest boundaries which had not been demarcated at the time of survey may be inserted thereon, during the ensuing field season.

108. In consultation with the Survey Commissioner and the Conservator of Forests, Colonel Pullan has drawn up the following programme of work for the ensuing season:—

(i) The completion of the 4-inch survey of the forests of Khed *taluka*; certain portions of the forest containing teak to be done on the 8-inch scale.

(ii) The survey on the 16-inch scale of the "Babul reserves" fringing the rivers Bhima, Nira, Ghod, and Mutha Mula.

(iii) The completion of the 8-inch survey of Karjat and Kalyán and the survey on the same scale of as much of the forests of the Bassein *taluka*, district Thana, as can be done before the break of the monsoon.

(iv) The supplementary triangulation and traversing of the *talukas* of Sálsette, Pen, Panvel, Roha, and Alibág.

(v) Completion of the survey of the forests in Supa *taluka* and portions of the forests of Kalghatgi and Yellápur, in advance of which triangulation will be extended from the base Ramankop-Mendsi, of the Mangalore Meridional series, *viâ* Yellápur to Kárwár.

109. The recess office of the party was inspected by the Surveyor-General in July 1889, who was satisfied with the general efficiency of the establishment and the progress and style of the mapping.*

MADRAS PRESIDENCY.

No. 19 Party.

110. The party, of the strength given in the margin, took the field during the first week in November 1888 to undertake, in accordance with the programme detailed in the last report, the survey of the forest reserves situated in the three districts, Salem, Madura and Tinnevelly, and for this purpose the party was divided into three sections, one for each district. The work of the Salem section was restricted to triangulation and traversing, as this district was being entered for the first time; whereas the work of the other two sections included topography, traversing and some supplementary triangulation, owing to that previously executed (for the 1-inch survey) not being sufficiently close for the topography on the 4-inch scale, which is that adopted for the maps of the forest reserves.

Personnel.

Major J. R. McCullagh, R.E., Deputy Superintendent, 3rd grade, in charge.
Mr. C. F. Hamer, Surveyor, 3rd grade.
„ H. Todd. do., 4th do.
„ R. Todd, Assistant Surveyor, 1st grade.
„ R. W. Senior, do. do., 2nd do. up to the 14th April 1889.
Mr. T. J. J. Mills, Assistant Surveyor, 2nd grade.

Sub-Surveyors.

T. Raghava Ayengar, V. Tiruvenkatsami, Lachman D. Jadow, Balaji Dhondhiba, Govindraju Mudliar, and 4 others, and 14 apprentice sub-surveyors.

111. The country embraced by the new triangulation is the southern part of the Salem district, but here, as well as in other parts of the country, the reserves are much scattered, which necessitated a good deal of judgment in the laying out of the triangles so as to economise stations as much as possible where they were only required to preserve the connection, and yet to have sufficient to obtain the maximum number of points in and around the reserves. This triangulation is based on the sides of the Great Arc Series, and has an area of 1,000 square miles, obtained by observations at 53 stations from which 360 points and 333 heights were obtained. The supplementary triangulation, the area of which has already been taken into account, includes observations at 42 stations, by which 176 new points were fixed and 162 new heights determined.

112. The traverses surveyed this season aggregate 240 linear miles and include the boundaries of the reserves which were surveyed in detail, as well as advance work. In connection with this part of the operations considerable difficulty was experienced owing to faulty demarcation and to the lines not being cleared in time, which entailed constant stoppages; the physical difficulties also were in some cases enormous, owing to the differences of level which had to be surmounted, in one instance the line having to be carried over a rise of nearly 6,000 feet in a distance of about 3 miles.

113. The area topographically surveyed on the 4-inch scale, covers 168 square miles, and the smallness of the out-turn is to be attributed to the following causes:—

(*a*) The very wet and unfavourable weather which prevailed just as the party took the field, lasting for about two months.

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* Colonel Pullan reports on his assistants as follows:—

"Mr. Lawson has done most excellent work throughout the season. I wish here to express my great satisfaction with his celerity, forethought and energy. In recess quarters Mr Lawson is the life and soul of the office, and is a very rapid and finished draftsman.

"Mr. S. Norman did a very satisfactory season's work. He is an excellent teacher, and is very much liked and respected by his native subordinates.

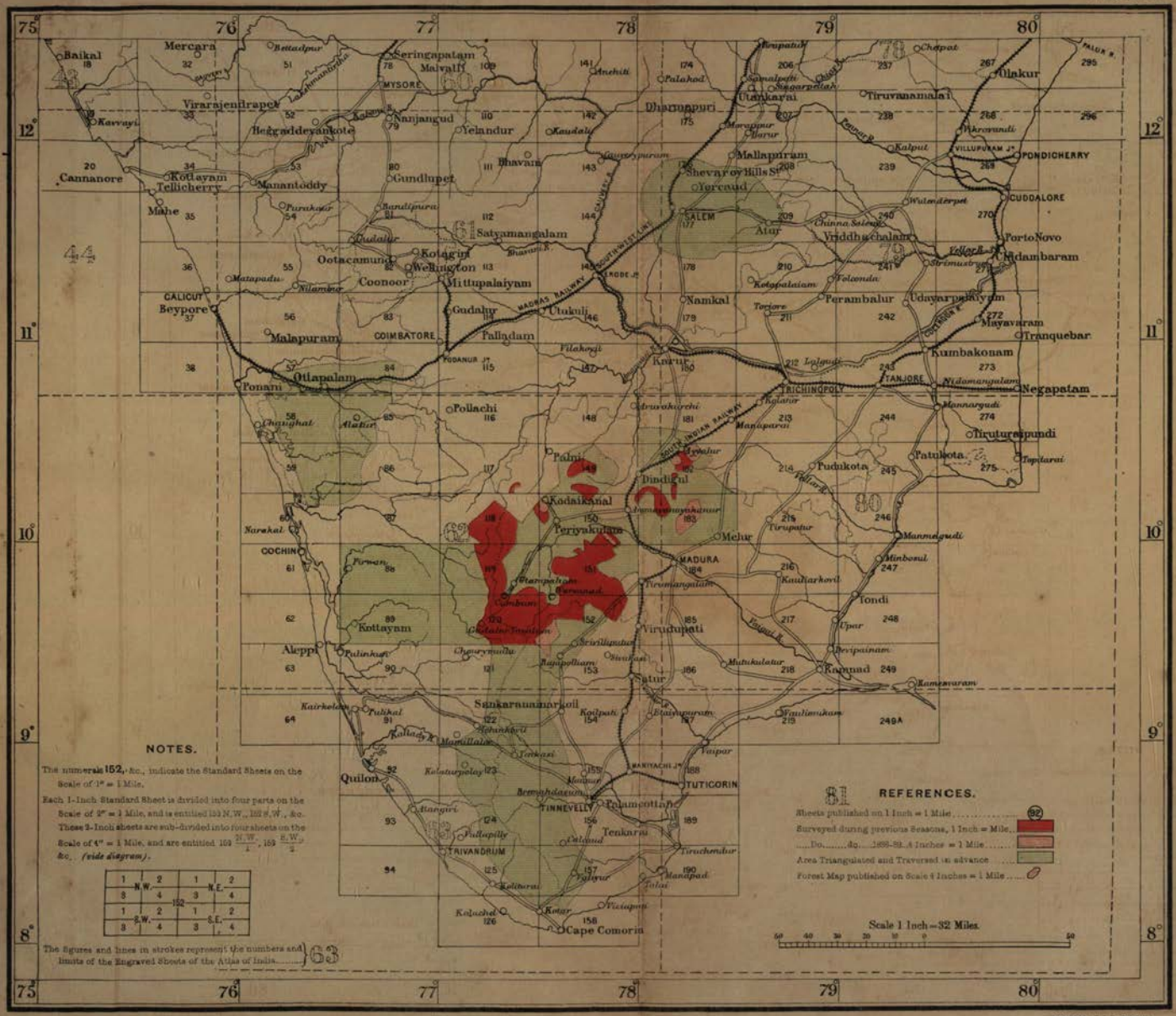
"Mr. C. Norman has given me much satisfaction. He is a very honest workman and thoroughly reliable.

"I had no reason to be dissatisfied with Mr. Serrao during the few months he served in the Bombay Forest Survey."

MADRAS SURVEY.

INDEX TO THE SURVEY OPERATIONS IN MADRAS.

No. 19 PARTY.



NOTES.

The numerals 152, &c., indicate the Standard Sheets on the Scale of 1" = 1 Mile.

Each 1-Inch Standard Sheet is divided into four parts on the Scale of 2" = 1 Mile, and is entitled 152 N.W., 152 S.W., &c. These 2-Inch sheets are sub-divided into four sheets on the Scale of 4" = 1 Mile, and are entitled 152 $\frac{N.W.}{1}$, $\frac{152}{1}$ $\frac{S.W.}{2}$, &c. *(vide diagram)*.

1	2		1	N.E.	2
N.W.					
3	4		3		4
		152			
1	2		1		2
S.W.			S.E.		
3	4		3		4

The figures and lines in strokes represent the numbers and limits of the Engraved Sheets of the Atlas of India 63

REFERENCES.

Sheets published on 1 Inch = 1 Mile ..... (92)

Surveyed during previous Seasons, 1 Inch = Mile.

.....Do.....do..... 1888-89. 4 Inches = 1 Mile .....

Area Triangulated and Traversed in advance .....

Forest Map published on Scale 4 Inches = 1 Mile .....

Scale 1 Inch = 32 Miles.

50 40 30 20 10 0 50

Reg. No. 961, S. I. D.—5-5-90—180

Photo-litho., S. I. O., Calcutta.

(*b*) The amount of sickness which existed amongst the establishment.

(*c*) The extreme difficulty of the ground to be surveyed, and the boundaries not being clear sufficiently in advance.

(*d*) The weakness of the party in trained sub-surveyors, and the loss of working power consequent on the assistants and trained men being hampered with the instruction of apprentices. This was due to the re-organisation of the establishment, consequent on the change in the character of the survey on which the party had previously been employed.

Moreover the circumstance of the operations having to be carried on in forests, or where forest growth continually obstructs the view, caused the work to be painfully slow and laborious. Major McCullagh reports that the survey of the forests in Madura and Salem is an arduous undertaking but that the difficulties to be encountered in connection with those in the Tinnevelly district can hardly be surpassed.

114. In consequence of the party having suffered in health very severely the previous year from staying out in the field later than was prudent, and as March, April and May are notoriously unhealthy months in the forest tracts, a recommendation was made to alter the ordinary dates of commencing and closing field operations by advancing the time of taking the field from the 1st November to the 1st September; this arrangement having been approved by the Board of Revenue, the operations were closed by the end of March, which saved the health of the establishment to some extent compared with the previous year, though there was still a large amount of sickness experienced towards the end, particularly in the Tinnevelly section.

115. During the recess the computations have been brought up to date and the fair maps of four reserved forests in Madura have been completed, namely, No. 47 Mudimalai, No. 65 Pillayar Nattam, No. 67 Alagar Malai, and No. 78 Vikkramangalam. A large reserved forest in Tinnevelly has, however, not been fair-mapped; it has been held over until the survey of the adjoining reserved land is finished, as the whole will eventually form one reserve, and it will be more convenient, as well as a saving of labour and expense, to have one complete map of the whole instead of two maps. In addition to the regular mapping, traces of the reserves had to be prepared at the request of the Forest Department and with the approval of the Board of Revenue, which on completion were passed on to the District Forest officers for the verification of boundaries, rights of way, holdings, &c., and final numbering of pillars, so as to guard against any omissions, and to avoid any errors in respect to these items creeping into the fair maps. This process, though adding considerably to the work in office, is no doubt necessary where demarcation is as defective as has been found to be the case so far, and when surveyors have to trust very much to their own judgment, aided only by the information obtained from forest guards and watchers, whose ideas of minute accuracy as to boundaries are sometimes vague.

116. During the coming field season the party will resume operations in the districts of Salem, Madura, and Tinnevelly.*

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* Major McCullagh reports that all his assistants worked hard and gave satisfaction during the field season as well as in recess, and that Messrs. Hamer, H. Todd, R. Todd, and Mills are deserving of special mention.

Of the sub-surveyors, Raghava Ayengar, Lachman D. Jadow, Balaji Dhondhiba, Ramaswami Naidu and Anantarao Dhondhiba are favourably mentioned, but the apprentices with a few exceptions have turned out badly and given hardly any return for the time, labour and money spent upon them.

LOWER BURMA.

No. 20 Party.

117. During the season under review this party was engaged on the survey of forest tracts in the districts of Prome and Toungoo, and on triangulation in Thayetmyo district. The strength of the party is shown in the margin.

Personnel.

Lieutenant-Colonel R. Beavan, S. C., Deputy Superintendent, 3rd grade, in charge from 20th December 1888.
Lieutenant W. H. Pollen, R. E., Officiating Deputy Superintendent, 4th grade, in charge from 20th November to 20th December 1888.
Mr. M. J. Ogle, Surveyor, 2nd grade, in charge up to 20th November.
Mr. J. A. Barker, Surveyor, 4th grade.
Mr. J. H. Wilson, Assistant Surveyor, 1st grade.
Mr. C. P. Torrens, do. do., 1st grade.
Mr. W. H. Penrose, do. do., 1st grade.

Sub-Surveyors.

Venkat Swamy, Abdulla Khan, Sharf-ud-din, Gridhari Lal, Hpo Noung, Amjad Ali, and 14 others.

118. The work the party is engaged on is being done chiefly for the purposes of the Forest Department. The reserved forests are being surveyed on the scale of 4 inches to a mile, and the intervening tracts on the scale of 2 inches to a mile.

119. The party took the field at the end of November 1888, making Prome their starting point. They continued in the field till driven in by the rains, in the end of May 1889. One of the assistants was placed in charge of the traverse surveyors, and another in charge of the detail surveyors; the remaining two were employed on triangulation. The officer in charge exercised a general supervision, visiting and inspecting the parties at work, and arranging for their being kept provided with supplies from Prome. For the commissariat 15 elephants are kept up, and this number is barely sufficient for the work, as there are no villages and no roads in these reserved forests: it naturally follows that no supplies are procurable on the spot.

120. As only 45 square miles were ready traversed on the 4-inch scale at the commencement of the season's work, only six sub-surveyors could be employed on detail survey at first, until more traverses had been run, computed out, and plotted; the remainder of the detail sub-surveyors were employed on 2-inch survey. Altogether there were eight traverse parties; six parties on 4-inch detail, and four on 2-inch detail in December. Later in the season the number on 4-inch work was increased.

121. The out-turn of work for the season comprises 210 square miles of triangulation, 150 square miles of topography on the 4-inch scale, and 162 square miles on the 2-inch scale.

122. Colonel Beavan reports on the country operated in as follows:—

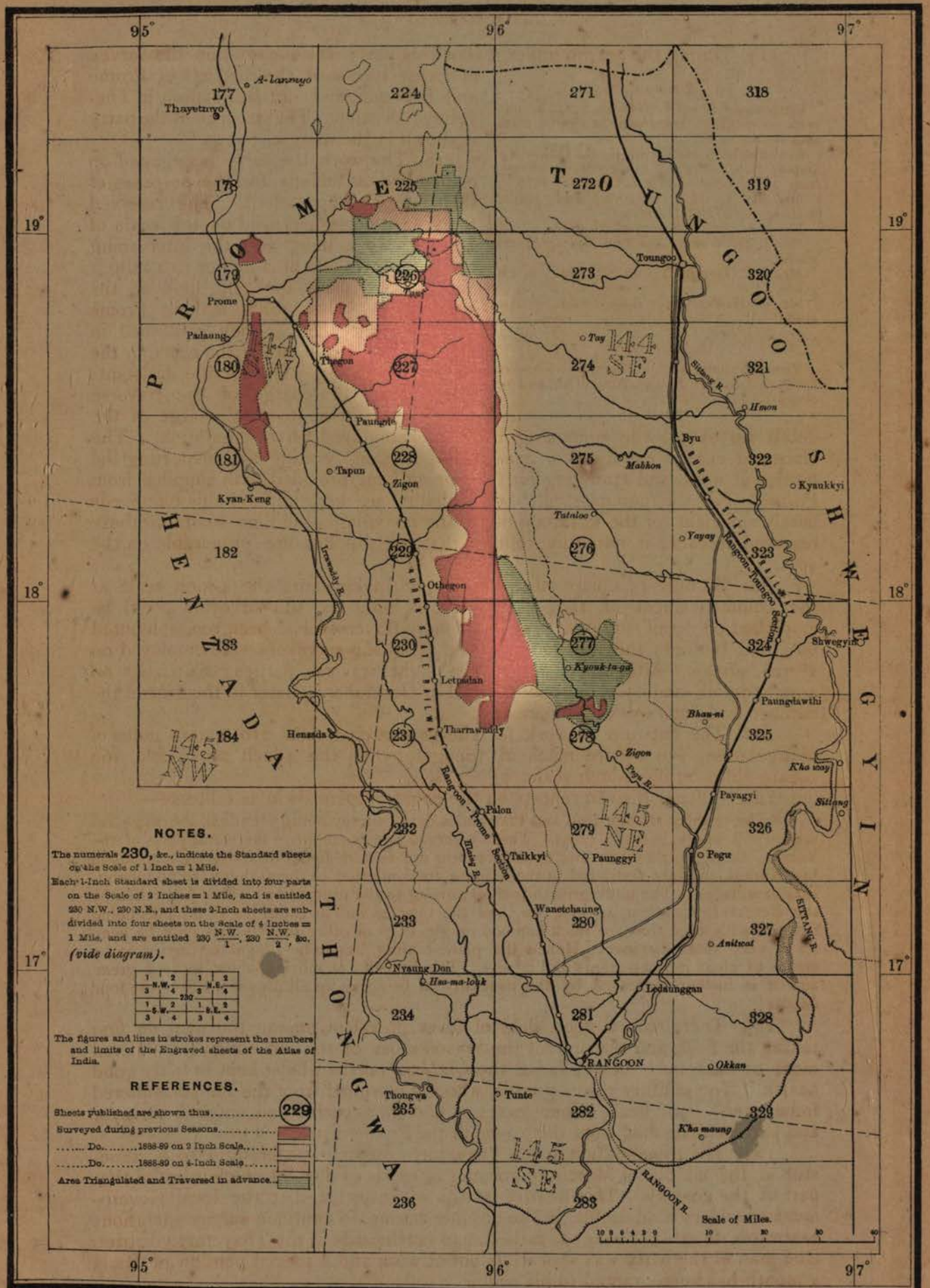
"The country triangulated and that under detail survey being identical, the same remarks will apply in both cases. These reserved forests comprise the worst parts of the Yomas; there are no roads, and even footpaths are seldom found to exist. Excepting a few Karens, who are restricted to the definite areas allotted to them, there are no inhabitants or villages The undergrowth is thick, owing to the precautions which are taken by the Forest Department against fire, and the tops as well as the sides of the hills being covered with large trees, or thick bamboo jungle, flags or other objects can only be seen for a very short distance. Hence the plane-tabling has to be altogether carried on by means of chain measurements and offsets. The difficulty of moving about is very great, and it is further increased by the necessity of bringing up all provisions from the food depôts."

123. There was a good deal of fever prevalent among the men on first taking the field, and throughout the season most of the sub-surveyors suffered more or less from sickness, but the *khalâsis*, on the whole, kept in fairly good health. The military police guards, who are recruited from the Punjab, suffered from fever a good deal. Some cases of cholera occurred and one sub-surveyor and two *khalâsis* died from this cause in the Prome district.

124. The triangulation in the Thayetmyo district was brought to a standstill in the middle of March on account of bands of dacoits which infested that part of the country. This district is still so unsettled that the local Government considers it advisable, in the ensuing season, to continue survey operations eastwards towards Toungoo, rather than northwards in the Thayetmyo district. One man of the party was shot while out at work and a special pension of Rs. 5 a month has been granted to his widow.

BURMA SURVEY.

INDEX TO THE FOREST SURVEYS IN LOWER BURMA. No. 20 PARTY.



NOTES.

The numerals **230**, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

Each 1-Inch Standard sheet is divided into four parts on the Scale of 2 Inches = 1 Mile, and is entitled 230 N.W., 230 N.E., and these 2-Inch sheets are subdivided into four sheets on the Scale of 4 Inches = 1 Mile, and are entitled 230 $\frac{\text{N.W.}}{1}$, 230 $\frac{\text{N.W.}}{2}$, &c. *(vide diagram).*

1	2	1	2
3	N.W. 4	3	N.E. 4
230			
1	2	1	2
3	S.W. 4	3	S.E. 4

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Atlas of India.

REFERENCES.

Sheets published are shown thus..... 229

Surveyed during previous Seasons.....

..... Do. .....1888-89 on 2 Inch Scale.....

..... Do. .....1888-89 on 4-Inch Scale.....

Area Triangulated and Traversed in advance.....

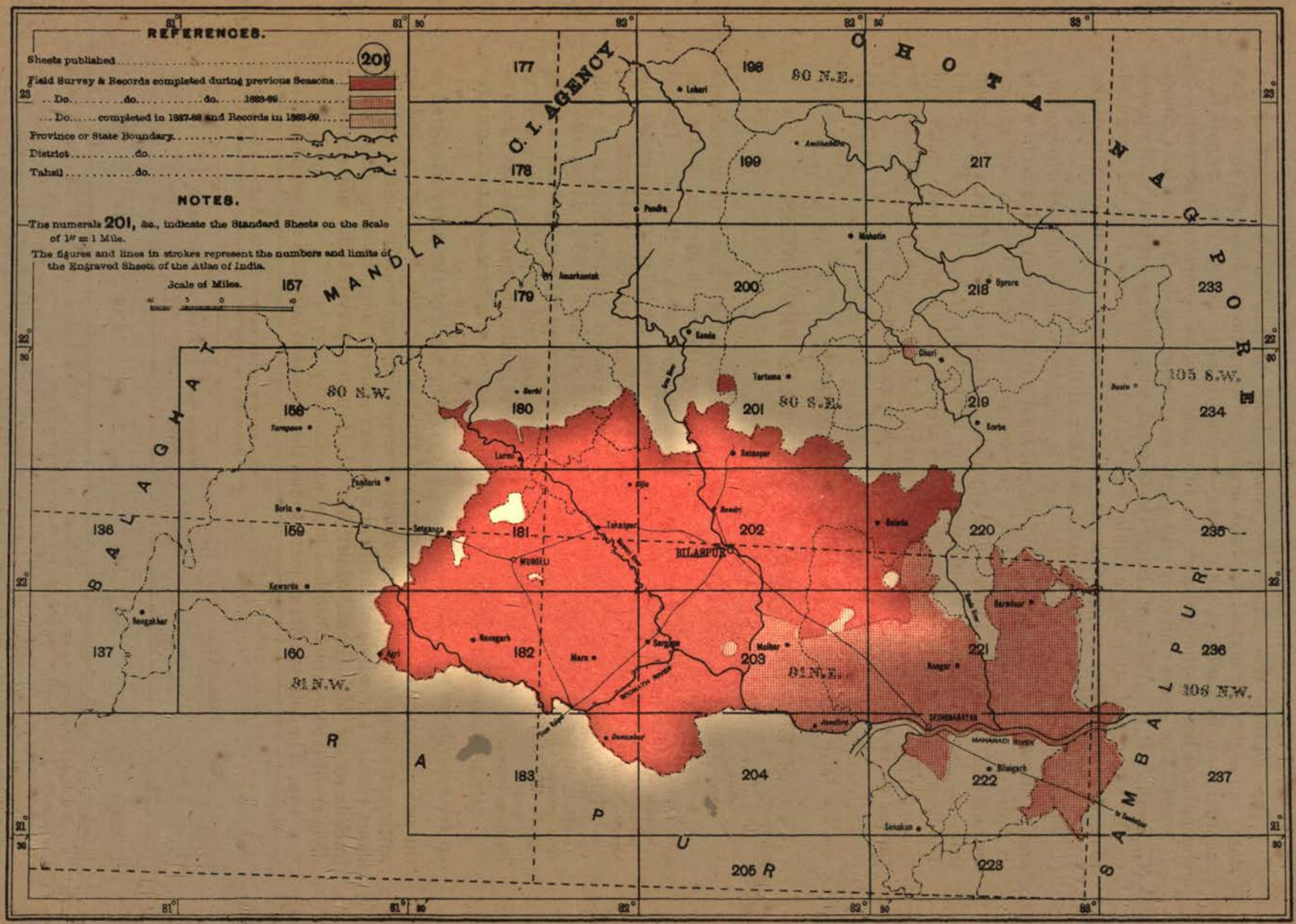
Reg. No. 989, S. I. D.—20-2-90.—580.

Photo., S. I. O., Calcutta.

CENTRAL PROVINCES SURVEY.

INDEX TO THE SURVEY OPERATIONS IN DISTRICT BILASPUR.

No. 2 PARTY.



Reg. No. 955, S. I. D.—17-3-00—350

Photo., S. I. O., Calcutta.

125. Mr. J. H. Wilson, Assistant Surveyor, fell a victim to the climate. He was not in good health on taking the field, and throughout the season he suffered almost constantly from fever. On the way back to recess he had a stroke of paralysis from which he never recovered, and eventually died in Calcutta.

126. The services of Mr. C. P. Torrens have been placed at the disposal of the local Government for employment in the Land Record Office.

127. During the recess the computations have all been brought up to date, and eight fair maps have been drawn; also portions of 2-inch sheets for incorporation in Calcutta with maps previously published. Four 2-inch fair sheets have been partially drawn, but they could not be completed this year.

128. The recess office of the party was inspected by Lieutenant-Colonel C. Strahan, R.E., Assistant Surveyor-General, who, during his visit to Rangoon for the purpose of attending a conference with the local authorities, was deputed to inspect the survey parties recessing there. He reports very favourably of the state of the records and the general efficiency of the office.

129. The party will take the field again about the middle of November, and during the ensuing season will be engaged almost entirely on 4-inch work, in order to keep the men within a smaller area and thus avoid the difficulties encountered last season in regard to supplies, as well as to ensure their protection from the bands of dacoits still remaining in the hilly tracts of the Prome and Toungoo districts. It is expected that an area of about 300 square miles will be surveyed on the 4-inch scale. Traverse and triangulation in advance will be carried on in the unfinished portion of the Kaboung forest.*

CADASTRAL SURVEYS.

BILASPUR DISTRICT, CENTRAL PROVINCES.

No. 2 Party.

130. The strength of this party was reduced by the transfer of the traverse section together with Messrs. Kraal and Barker for new work in Bengal. The remainder of the party continued under the charge of Lieutenant-Colonel Steel. Field work was carried on from November 10th, 1888, to April 20th, 1889, when the field office, comprising the establishment for the computations and mapping, proceeded to Mussooree, whilst the establishment for the completion of the vernacular records recessed at Kamptee.

Personnel.

Lieutenant-Colonel E. H. Steel, Deputy Superintendent, 3rd grade, in charge.
Mr. F. Grant, Assistant Superintendent, 1st grade.
„ J. McHatton, Surveyor, 4th grade.
„ P. C. H. Smart, Assistant Surveyor, 1st grade.
„ F. W. Moore, Assistant Surveyor, 2nd grade.
3 sub-surveyors.

Temporary Establishment.

243 field surveyors and others.

131. The work of the party consisted in the completion of the cadastral survey of Bilaspur, *i.e.*, the field survey and the writing of village registers; the traverse survey having been finished in the previous year. The whole of the field work was placed under the immediate superintendence of Mr. Grant, whilst Mr. McHatton supervised the office work, a division of labour which worked most satisfactorily.

132. The following statement shows the work that has been accomplished:—

District.	Records written only: Surveyed in 1887-88.		Cadastrally Surveyed and Records written.	
	Number of villages.	Area, square miles.	Number of villages.	Area, square miles.
Bilaspur	3	14·14	541	914·86

* Colonel Beavan reports favourably on the services of his assistants, Messrs. Barker, Wilson, Torrens and Penrose, all of whom had very arduous duties to perform.

Regarding Mr. Wilson's death, Colonel Beavan remarks: "His loss is much felt in the party as he was a hard-working and efficient officer;" and in reference to Mr. Torrens' transfer: "His loss will also be seriously felt in this party. Another assistant has been transferred, so that next field season there will be only one of the old hands left with the party."

The sub-surveyors and apprentices are also reported to have worked satisfactorily.

Harlal Singh, office clerk, is especially brought to notice as having worked most assiduously.

The number of fields surveyed was 1,722,295, and the *khasra* numbers amounted to 523,130. The average size of the field was 0·2 of an acre, and in many places they did not exceed the size of an ordinary room; these have all been carefully mapped, but, as was done last year, all plots which touch one another and are under the same tenure, crop and soil have been recorded under one *khasra* number.

The record-writing was as usual based on information obtained on the spot, checked as far as was possible by the *patwári* papers of the last 20 years.

133. Both the survey and the writing of the records were carefully checked, the former by check lines aggregating 1,032 linear miles run during the progress of the work, as well as by 773 linear miles measured after the completion of the maps; and the latter by the examination of 81,596 numbers distributed amongst 544 villages.

134. In addition to the preparation of the *khasra*, the party undertook the valuation (besides the classification) of the soils with regard to their capacity for retaining moisture. The work of training the survey staff in this valuation of the soils and of supervising the checking staff of *patwáris* fell almost entirely on the European officers of the party, and proved to be of a very onerous nature. The method of entering the position, class of each field and the soil twice over, once on a form and once on the *khasra*, and comparing differences, has ensured a high class of record on these points. The rents and tenures have also been checked at the same time. The work of this year is a distinct advance in value for settlement purposes over that of last year. To assist in this work the Settlement officer provided 22 excellent *patwáris*, the best nearly that he had, but they proved to be but little if at all better than the survey *amins* for the purpose.

135. Of the demarcation Colonel Steel reports as follows:—"The demarcation of the villages was excellent; in all my service in the Department I have never seen better demarcation: this is solely due to the Settlement officer, Rai Bahadur Parshotum Dass. The relations between the Survey and Settlement Departments were excellent: it would be impossible with a gentleman of Rai Parshotum Dass's stamp for them to be otherwise."

136. Colonel Steel also drew up for the Deputy Commissioner of Bilaspur, a scheme for surveying the *zamindari* lands and made over two of his best men to teach *patwáris* and start the survey. He also made over three of his best *amins* to the Settlement officer of Raipur to help in training his *patwáris* in writing up the *khasras*.

137. The cost rate for the current year for the two operations of the field survey and record-writing, including stone-embedding, is ₹120, whilst that of last year was ₹98. The increase is due to the excessively small size of the fields.

138. The survey of the Bilaspur district is now finished, and all the records were lodged with the Settlement officer by the end of October 1889. The particulars of the work and the final account showing the cost and cost rate for the entire survey will be found at page 79.

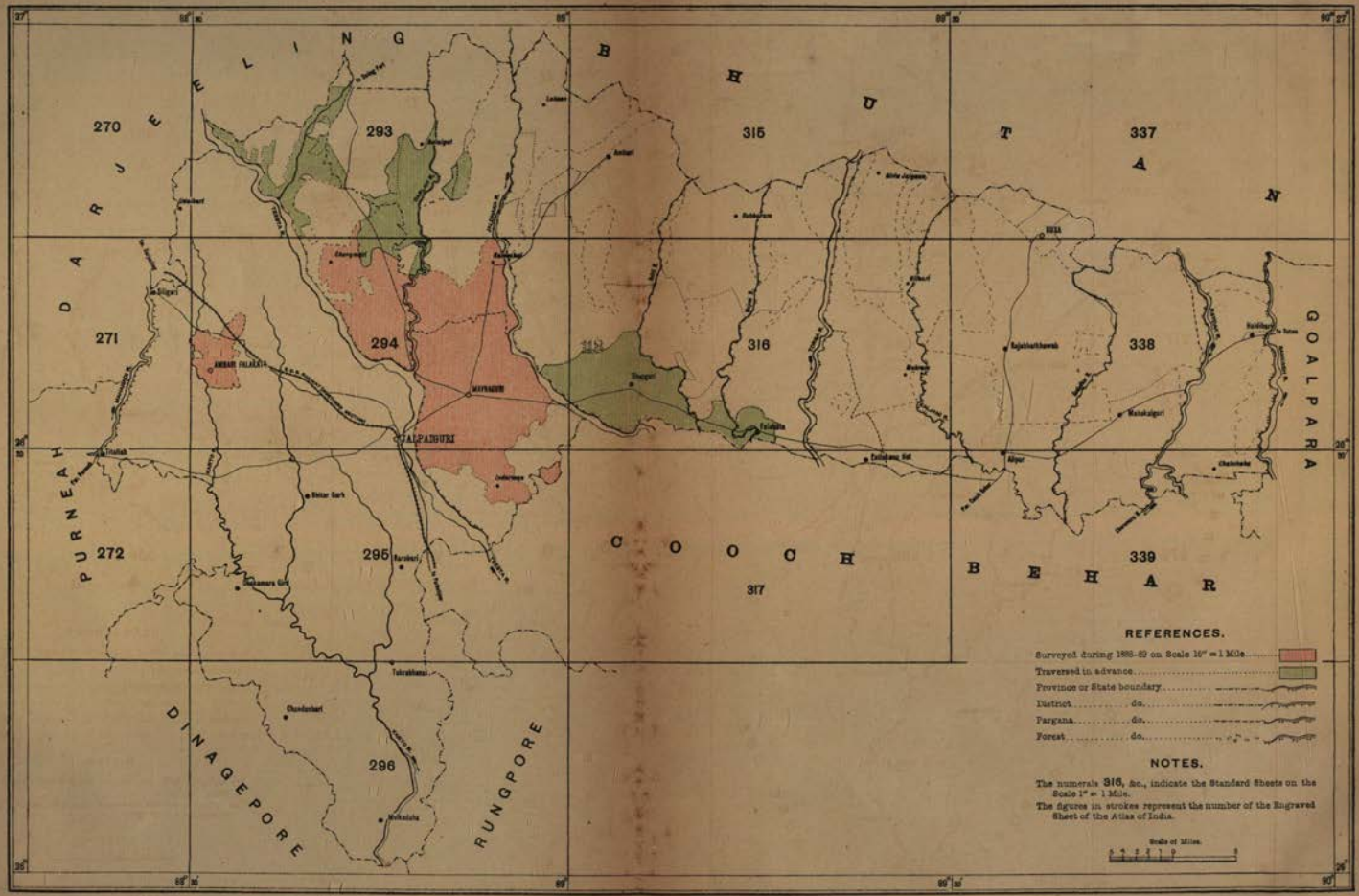
The tenants have everywhere afforded all possible help to the survey, and by far the greater part of the *málguzars* have also rendered willing assistance.*

* Colonel Steel writes thus of his European officers, Messrs. Grant, McHatton, Smart and Moore:—"Their work and their conduct have been excellent; I have been met on all sides with ever-ready help." Of the native staff he specially mentions Pundit Ramji Lal, Karur Hussein and Golam Abbas.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN THE WESTERN DOOARS (DISTRICT JALPAIGURI).

No. 4 PARTY.



Reg. No. 6, S. I. D.—10-1-90.—1,050.

Photo-Zinc., S. I. O., Calcutta.

WESTERN DOOARS.

No. 4 Party.

139. This party, on completing its allotted field work in districts Basti and Mirzapur, North-West Provinces, was transferred to the Western Dooars in Bengal, where a cadastral survey was required.

140. After the close of the recess season it was divided into two detachments, the main one proceeding to Jalpaiguri to commence the survey of a portion of the cultivated tracts in *tahsil* Mainaguri, *viz.*, those in *parganas* South Mainaguri, North Mainaguri and Chengmari; and the other, consisting of a selected number of draftsmen and computers, going to Calcutta, to complete the records of districts Basti and Mirzapur, prior to their being lodged at head-quarters. The whole party was placed under the charge of Lieutenant-Colonel S. H. Cowan from 1st November 1888, but in February 1889, that officer was transferred to No. 8 Party, and Mr. Hanby took charge, which he continued to hold for the remainder of the season under report.

Personnel.

Lieutenant-Colonel S. H. Cowan, Deputy Superintendent, 3rd grade, in charge from 1st November 1888 to 16th February 1889.
Mr. H. T. Hanby, Surveyor, 3rd grade, in charge to 31st October 1888, and again from 17th February to 30th September 1889.
Mr. W. C. Price, Surveyor, 3rd grade, to 28th February 1889.
„ L. F. Berkeley, Assistant Surveyor, 1st grade.
„ R. F. Warwick, „ „ „
„ W. E. Johnson, „ „ 2nd grade.
20 sub-surveyors and others.

Temporary Establishment.

Cadastral, including the Record of Rights section of district Jalpaiguri. } 220 field surveyors and others.

141. Owing to the absence of recognised *mauzas* or villages, it was found necessary to make some alterations in the system of survey and record writing. The only territorial divisions bearing definite names in the Western Dooars are *parganas* and *talukas*; the latter are subdivided into plots of various sizes called *jots*, which are distinguished by the name of the tenant (*jotdar*) or of his successors, and by serial numbers called *tauzi* numbers. The *taluka* is too large, and the *jot* too small to serve as a survey unit, so it was decided to club several *jots* together, so as to make up areas approximating to the size of the *mauza* in the North-West Provinces and to treat them as the unit of survey, but the *jot* is the unit recognised for Settlement purposes. These blocks of congregated *jots* are called *chaks*, which have been numbered consecutively for each *taluka*. The style of record writing too is different from that in use in the North-West Provinces, both in the character of the entries as well as in the number and description of the records. One tracing only of the map, together with the records appertaining thereto, has been required.

142. Field work was commenced on the 1st November 1888, and it finally ended on the 15th June 1889, a portion of the party having closed a week earlier. The recess office of the party was opened at Hazaribagh on the 18th and 24th June 1889 by the two sections of the establishment as they arrived.

143. The cadastral survey, together with a complete record of rights of a portion of *tahsil* Mainaguri, has been completed this year. The remaining portions of the cultivated tracts of the *tahsil* have been traversed in advance and will be completed early next season. A portion of *parganas* Maraghat, Lakhipur and West Madari, has also been traversed in advance, and a part of the boundary between the Cooch Behar State and Jalpaiguri was taken up and mapped on the scale of 4 inches=1 mile, ready for comparison with the maps of the survey made under Mr. Renny in the year 1872.

144. For want of a sufficient number of Bengali *amins*, the record writing has been mainly done in Urdu, which was afterwards translated into Bengali in office. This procedure manifestly added greatly to the work and was objectionable in that it was likely to introduce errors. But it was unavoidable during this the first season in Jalpaiguri; every effort will be made in future to introduce Bengali *mohurrirs* and *amins* and so avoid these double records. The papers submitted for the field were the *khasra*, *khatian* slips, the *fard hissa kashi* or detail of sharers in the *jots*, reference list of names, dispute list, reference list of uncultivated items, and a Bengali list of all the names occurring in

the *khasra*. The records prepared for the Settlement Department consisted of (1) the *milan khasra*, which comprises a statement of soils, a modified statement of crops and details of culturable waste lands; (2) the *khatian*, which contains the extent and nature of each holding with names of proprietors, tenants, and sub-tenants, classification of soil and details of uncultivated items with their areas and also the names of the cultivators of adjoining fields; and (3) the abstract of *khatians*, showing the totals of the holdings which form complete properties, the areas of the several descriptions of assessable uncropped lands, the entire area of the *jot* as well as a statement giving the area of the different descriptions of waste lands. The areas were entered in English acres and decimals. The crops were divided into *bhadoi* or autumn crop, the *rabi* or winter crop, and the *haimanti* or winter rice crop. The soils were divided into two heads, *viz.*, *rupit*, the low-lying lands, and *faringati*, the up-lands, each of which was subdivided into three classes, the latter occasionally having four classes.

145. The following table shows the areas which have been surveyed both cadastrally and in traverse:—

Pargana.	Traverse Survey.		Cadastral Survey, 16 inches=1 mile.					Remarks.
	Number of *chaks*.	Area in square miles.	Number of *chaks*.	Number of *jots*.	Area in square miles.	Number of fields.	Number of *kiaris* (subdivisions of fields).	
Amhora Falakata	42	14·99	42	42	15·37	21,526	14,121	With complete record of rights.
South Mainaguri	111	98·79	110	1,000	98·85	1,53,028	54,291	
North Mainaguri	25	18·98	25	331	19·17	36,379	10,505	
(*Interlaced.*)								
North Mainaguri	242	134·80	47	322	28·46	23,549	8,519	
(*Proper.*)								
Chengmari	298	109·53	99	528	46·06	44,378	16,298	
Moraghat	279	58·05	...	...	...	...	...	
Lakhipur and West Madari	69	14·92	...	...	...	...	...	
	1,066	450·06	323	2,223	207·90	2,78,860	1,03,734	
Chengmari	...	...	6	18	2·45	3,749	...	Surveyed only.
	1,066	450·06	329	2,241	210·35	2,82,609	1,03,734	

146. The traversing of *chaks*, in advance of cadastral survey completed, amounts in the *jot* lands to 162 square miles containing 722 *chaks*, and in tea and forest land to 78 square miles: in the forest tract about 62 square miles of forest boundary work may eventually prove of service, if the Government Reserved Forests come under survey topographically. The average size of the fields in the area completed with records is 0·48 acres.

147. The field survey has been tested by 583 lineal miles of check survey, of which 165 miles were measured and compared in the field with the surveyor's maps by European officers, while 53 independent *partals* done on field books by sub-surveyors and others were compared in office by one or more of the European officers. The remaining 365 miles were surveyed and passed by the inspectors in the field. Azimuth observations were taken at average intervals of 5·6 miles or at about every 30 stations on the main circuits, and at 7·2 miles or 42 stations on sub-circuits. The traverses have been connected with five principal and one secondary station of the Great Trigonometrical Survey and the average error of the Revenue Survey chaining is found to be 3 feet per mile. The details of the entries in the records of rights (*khasras*) of the cultivators of *jots* in 83,838 fields were tested, of which 89,995 entries were examined by European officers, and 74,834 by Native inspectors.

148. Stone prisms, $2\frac{1}{2}$ long with 5 inch sides, have been laid down at 3,465 stations; a small portion of the top of each was dressed to a triangular shape having 4-inch sides: there are about eight of these to every square mile. The

cost for the stones including carriage in the district has amounted to ₹3,918. If to this is added the cost of baked clay cylinders which equalled ₹714, and the cost of the establishment employed on embedding them, which was ₹1,787, the total cost for permanent marks amounts to ₹6,419, which gives an average of ₹14-6 per square mile without superintendence, or ₹17-14 with it. If the *jotdars* are called upon to pay any portion of the cost of these stones the rate will of course be proportionately lessened.

149. The cost rates of the different operations are given in the accompanying table :—

	Cost Rate.								
	Per square mile.			Per acre.			Per 100 fields.		
	₹	a.	p.	₹	a.	p.	₹	a.	p
For traversing	61	14	2	0	1	6·55	...	...	...
For detail survey, 16-inch scale	166	8	8	0	4	1·96	12	6	4
For preparing the records of rights, in field and office	79	5	3	0	1	11·9	5	14	7
For permanent marking	17	14	5·5	0	0	5·6	...	...	...

150. The difficulties the party has had to contend with have been very great. The most serious was the excessive sickness in the form of malarious fever, which from the commencement of the season to its close prostrated a very large portion of the establishment and materially impeded work; the others were the absence of all demarcation at the beginning of the season; the unwilling assistance and dilatoriness of the *jotdars;* the heavy line clearing, in the northern *parganas* especially; the difference of language and consequent delays; and lastly the want of forms which retarded the office work to a serious extent even up to the middle of the recess season. It is believed that many of these difficulties will be materially lessened during the next season; but the sickness, which is due to the nature of the country, must always be considerable, and it is hoped that it will not be every year as bad as it has been during the last season. The difference of language will be much less felt as experience is gained and as more Bengalis are gradually drafted in, and the want of local labour will be rectified by an increase of the native establishment which will render the *amins* more independent of the *jotdars*. Arrangements have also been made to prevent the delay caused by the non-arrival of the forms.

151. Receipts in duplicate have been taken for all records supplied to the local authorities, to whom the records of 694 *jots* were sent in 47 despatches; these consisted of 694 tracings, *khasras* and *khatians*, and of 444 *milan khasras* of *jots;* the abstract of *khatians* of 683 and the village papers of 694 *jots;* as well as areas of 105,788 fields amounting to 67 square miles. This represents only a portion of the work, which was commenced very late in the field season, and it is hoped that all records of the past season which are now nearly ready for submission will be finally lodged in January 1890, if the remaining disputed boundaries (45 in number and affecting 102 *jots*) are disposed of by the Settlement Department in time.

152. No junior civilians, *kanungos* or *patwáris* were attached for instruction to the party, but a few Bengalis, who came with a view to employment as *amins*, were taught. The attempt was not as successful as was desirable, but there are some hopes that the Survey School started at Barisa, near Calcutta, may give better results. The employment of Bengali *amins* to a greater extent than was found possible during the last season is most desirable and no effort will be spared to attain that object. At the same time no great hopes can be held out of its being attained, for men were specially selected to teach all those who would come for instruction prior to being appointed, the result was the entertainment of only 11 men. Of the Bengali *mohurrirs* who were appointed to assist the *amins* from the North-West Provinces by entering in the field in Bengali what the *amins* did in Urdu, Mr. Hanby reports thus :—

"The men entertained for this purpose left one by one as they declined to work in the sun and wanted to be given only office duties, or expected the *amin*, who had already worked all day, to read out to them at night what had been done during the day, so that they might copy in the necessary entries."

If this can be taken as a true sample of the type who will come forward for survey work, it does not hold out a very hopeful prospect for surveys conducted by local agency in Bengal.

153. The area remaining for cadastral survey in district Jalpaiguri is supposed to be about 322 square miles, but it is probable that the actual area will be found to exceed that amount, as numbers of new *jots* are annually being taken up. For traverse survey, the area remaining of the cultivated tracts is supposed to be a little over 150 square miles, but in the event of more cultivation being found than is at present anticipated, this may be exceeded. The remaining area of about 600 square miles, exclusive of the Forest Reserves, consists of arable waste lands, and of a portion of the territory held by the late Colonel Hadayet Ali, which extends over about 65 square miles and is not required to be surveyed.

154. Mr. Hanby reports that Major H. Boileau, the Deputy Commissioner of Jalpaiguri, rendered the survey, whenever it lay in his power, every possible assistance; and the Settlement officer, Mr. Walsh, by the issuing of and enforcing the carrying out of stringent orders, put a stop to proceedings on the part of one of the Deputy Collectors which at one time proved a source of embarrassment to the proper conduct of the work and a cause of complaint and discontent among the survey employés.*

155. The maps and records of the Basti district, North-West Provinces, in which this party had been previously employed, are now fully completed, and the following statement gives the final cost:—

Statement of cost rates for the survey of district Basti.

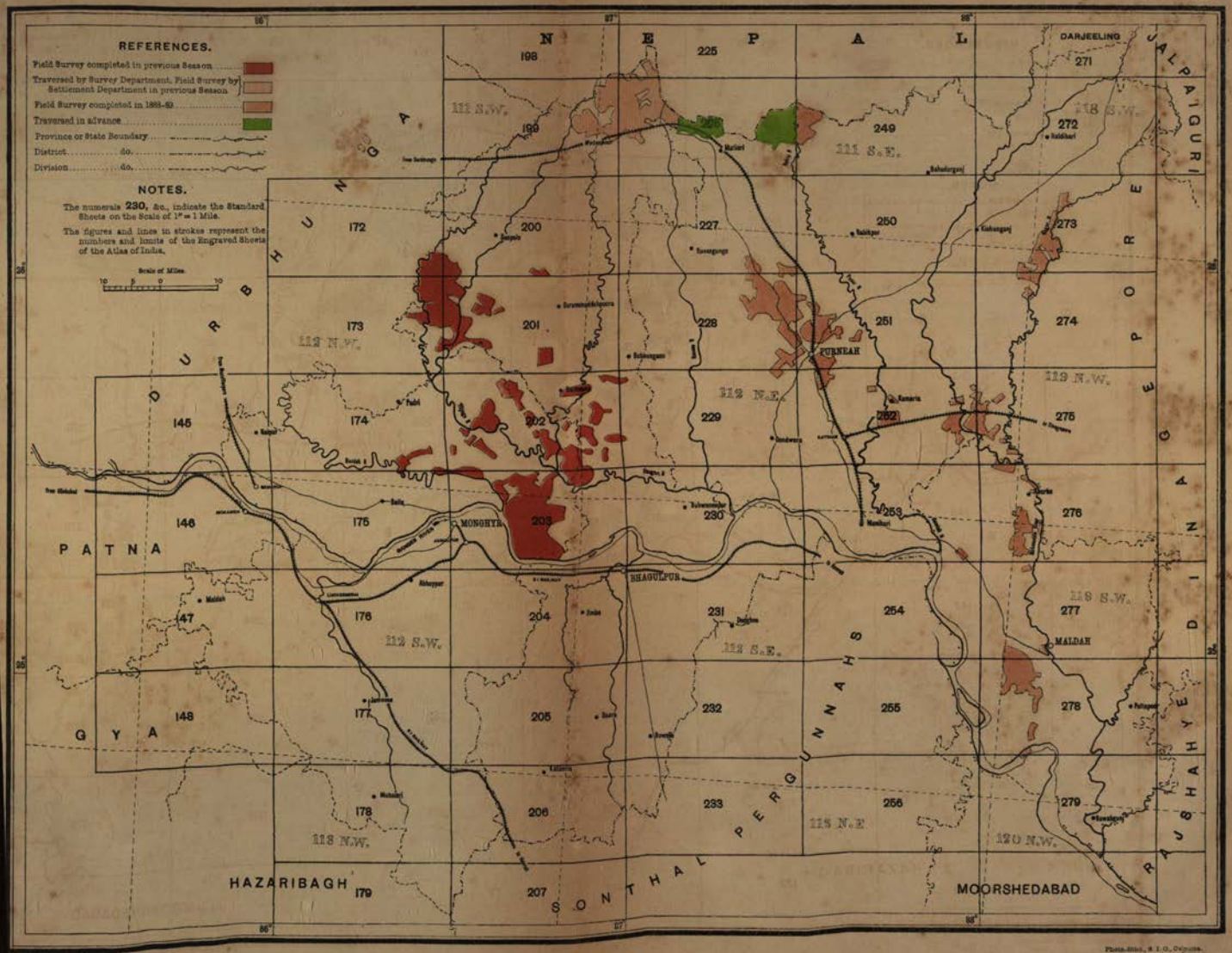
	Average cost rates.		Remarks.
	Cadastral Survey and Record of Rights excluding statistics.	Cadastral Survey and Record of Rights including cost of statistics.	
Rate per square mile . .	184 2 7	225 13 9	Cost of survey paid by Survey Department . . . = R. 5,18,606 9 10 — R 5,18,606 9 10 Cost of statistics paid by Survey Department . = 54,233 3 3 Cost of statistics paid by Settlement Department . = 63,095 2 8 — R 1,17,418 5 11
Do. Village . .	68 1 8	83 8 4	TOTAL . R 6 36,024 15 9
Do. Acre . .	0 4 7	0 5 8	This sum includes the cost of survey of certain villages transferred to Fyzabad, estimated at R2,551-14-2.
Do. 100 fields . .	9 13 9	12 1 5	
Average size of villages = 237 acres.			
Average size of fields = 0·34 acre.			

* Mr. Hanby commends the services rendered by Messrs. Price and Berkeley and favourably mentions Messrs. Warwick and W. E. Johnson. Of the permanent native establishment he reports that Jagneswar Bhuttacharjee, Meer Usjad Ali, Fuckroodeen, Bhowani Pershad, Ramjad Miser, Enayatulla, Wazirat Hussein and Promoth Nath Pal have all done well, and of the cadastral temporary establishment, he gives the names of Rahimuddin, Sadar Munserim, Kanaya Lall, Raj Bahadur, Abdul Hakim, Mackbul Ahmad, Arjun Pershad, Nawab Ali and Chet Ram.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN THE SRINAGAR ESTATE.

No. 4A. PARTY.



Reg. No. 4, S. I. D.—10-1-90.—1,000

Photo-Zinc., S. I. O., Calcutta.

SRINAGAR AND BANAILI JOINT ESTATES, AND BURDWAN KHAS MEHALS.

No. 4A Party.

156. The operations of this party were extended by the direction of the Government of Bengal to the survey of the Burdwan Khas Mehals in addition to the completion of the portions of the Srinagar and Banaili joint estates. The work in the Burdwan Mehals being quite distinct from that in these two estates, will be reported on separately.

Personnel.

Mr. G. B. Scott, Officiating Deputy Superintendent, 4th grade, in charge from 22nd October 1888.
„ W. J. O'Sullivan, Surveyor, 3rd grade, in charge, up to 21st October 1888.
„ T. Shaw, Assistant Surveyor, 1st grade, from 1st December 1888.
„ E. F. Berkeley, Assistant Surveyor, 2nd grade, up to 31st August 1889.
„ J. P. Barker, Assistant Surveyor, 2nd grade, from 1st November 1888.
„ F. B. Powell, Assistant Surveyor, 3rd grade.
8 sub-surveyors and others.

Temporary Establishment.

58 field surveyors and others.

157. In the Srinagar and Banaili estates but little traverse work remained to be done, and consequently only a small staff was told off to that duty; the villages were situated in the Maldah, Purneah and Durbhunga districts. The cadastral survey was undertaken also in the same districts, but as the estates were much scattered either in blocks or in isolated villages throughout the whole district, extending over a total length of 120 miles, it was found necessary to subdivide the detachment into two portions, each under European supervision; to one was allotted all the villages to the north, and to the other those to the south of Purneah and Maldah.

158. The traversing of the boundaries of such villages as were known to belong to the estate did not take long, but much time was afterwards lost whilst waiting for replies from the managers as to whether the traverse establishment might be withdrawn. Subsequently it was decided to survey the *chint-arazis*, or scattered blocks and isolated fields, which, though entered in the books of some of the *mauzas* (villages) of the estate, were more or less scattered in the lands of other estates. To ascertain the locality of these was most difficult; the names of the villages were not given and the estate officials were as ignorant of where they lay as the sub-surveyors, and no assistance could be obtained from the villagers, even if they did not offer actual opposition. To fix their position for future reference was a laborious operation, entailing much unnecessary work; there were no marks to indicate the boundaries of the villages in which they were situated, not even tri-junction marks, and it was found necessary in many cases to ignore the *mauza* boundaries and to connect the blocks by chain lines running across country when they were within reasonable distance of one another. The total number of these *chint-arazis* surveyed is 380; they are scattered in 78 villages and cover an aggregate area of $4\frac{1}{4}$ square miles. The expense and labour of surveying them is out of all proportion to their small area, and has added considerably to the average cost of the survey. The total area traversed, irrespective of the connecting lines, was about 39 square miles, which, added to the area traversed last season, gives a total of 745·53 square miles of boundary traverse. Of this area, 355 square miles were cadastrally surveyed last year, and 91 square miles were completed by the Settlement staff. Of the remainder, the survey of about 41 square miles in Tirakharda was rendered unnecessary, as that area had been lately made over entirely to the Banaili estate. Thus there were only 258 square miles remaining for cadastral survey; this area was completed by the 1st June 1889, field work having commenced on the 1st November 1888.

159. The following statement gives the areas surveyed in the Srinagar Wards' Estates during the two seasons 1887-88-89:—

Season of Survey.	District.	Pargana.	Traverse Survey.		Cadastral Survey.		Remarks.
			No. of villages.	Area in square miles.	No. of villages.	Area in square miles.	
1887-88	Bhagalpur.	Daphar	81*a*	91·16	...	...	*a* Cadastrally surveyed by settlement staff.
Do.		Kubkhand	75	83·91	5	83·91	
1888-89		Do.	6	4·79	6	4·79	
		Carried over	162	179·86	81	88·70	

Season of Survey.	District.	Pargana.	Traverse Survey.		Cadastral Survey.		Remarks.
			No. of villages.	Area in square miles.	No. of villages	Area in square miles.	
		Brought over .	162	179·86	81	88·70	
1887-88 .	Bhagalpur .	Uttarkhand .	25	39·48	25	39·48	
Do. .		NarsinghpurKhari	8	22·29	8	22·29	
Do. .		Chahi . .	7	22·33	7	22·33	
Do. .	Monghyr .	Farkia . .	117	182·11	117	182·11	
1888-89 .		Do. . .	9	8·05	9	8·05	
1887-88 .		Balia . .	1	4·94	1	4·94	
Do. .	Purneah .	Tirakharda . .	63*b*	75·78	26	34·12	*b* 37 villages assigned to Banaili in full possession after traverse.
1887-88-89		Haveli . .	51	95·67	51	95·67	
Do. .		Shahpur . .	2	1·93	2	1·93	
Do. .		Kodwa . .	15	8·66	15	8·61	
Do. .		Sujanagar . .	61	25·54	61	25·54	
Do. .		Tajpur . .	32	13·56	32	13·56	
Do. .		Dehat . .	4	16·44	4	16·44	
Do. .		Dharampur .	12	1·52	12	1·52	
Do. .		Scattered . .	...	4·20	...	4·20*c*	*c* Comprises 372 chint-arazis contained in 78 villages.
Do. .	Maldah .	Akbarabad .	35	17·13	35	17·13	
Do. .		Mahinagar .	68	19·69	68	19·69	
Do. .		Belwari Bhatia .	28	1·61	28	1·61	
Do. .		Bhatra Gopalpur .	3	0·11	3	0·11	
Do. .		Kotirali . .	11	1·93	11	1·93	
Do. .		Sujanagar . .	2	0·75	2	0·75	
Do. .	Durbhunga .	.....	6	2·05	6	2·05	
Do. .		Scattered . .	...	...	...	0·05*d*	*d* Comprises 8 chint-arazis.
	Totals for both seasons .		722	745·53	604*e*	612·81	*e* Exclusive of 380 chint-arazis.
	Reported last year .		610	706·40	233	355·06	
	Surveyed during current year .		112	39·13	371*e*	257·75	

160. The total cost of the operations is ₹1,20,825, which gives a rate of 4 annas 11 pies per acre for 613 square miles of completed survey. In addition to this are 133 square miles of traverse. The cadastral area included 343,798 *kiâris* (sub-divisions of "fields" for cultivating purposes) in 197,524 "fields." Round Purneah itself and in Maldah the fields were large and the country open, but in Tirakharda and Goalpokhar in North Purneah, the average size was 0·3 of an acre.

161. The demarcation of villages was carried out by the survey staff during progress of the survey, and was made according to possession, which in many cases differ from the boundaries shown on the old maps and of which there were no vestiges found. The embedding of stone marks at tri-junctions of villages and at certain traverse stations, which had been only temporarily marked last year, was carried on during the progress of survey by special *mohurrirs*, who were provided with plots on which were marked the sites at which the stones were to be embedded. These were all duly laid down with the exception of about 100 still to be embedded in the villages along the Mahananda to the north of Maldah. In consequence of the delay in deciding on the survey of the *chint-arazis*, the supply of stones to mark the selected stations round them was not received until after the party had returned to recess quarters. The officer in charge of the Burdwan detachment or the Settlement officer, as may be most convenient, will complete this.

162. The cadastral survey was carried on precisely under the same system as was adopted last year. No Bengali *amins* or *patwâris* were available as explained in paragraph 167 of the last Annual Report. The "field" boundaries were inked up and the areas calculated on the field by the *amins*, in *bighas* of 4½ *haths*. In Maldah it was decided to adopt for the present the Government *bigha* of 1,600 square yards and the areas were computed on this basis. The *raiyats* were at first strongly opposed to this, but were eventually persuaded to agree to it after personal interviews with many of the most influential of them.

163. In the absence of Bengalis capable of reading the survey sheets, it was necessary to write the vernacular records of the Maldah villages in Kaithi-Hindi, which was afterwards translated into Bengali in office; whenever, however, a Bengali writer could be obtained, the *khatians* were written in Bengali simultaneously with the *khasra*, which acted as a check, more especially in the writing of the names of the *raiyats*.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN THE BURDWAN KHAS MAHALS.

No. 4A PARTY.

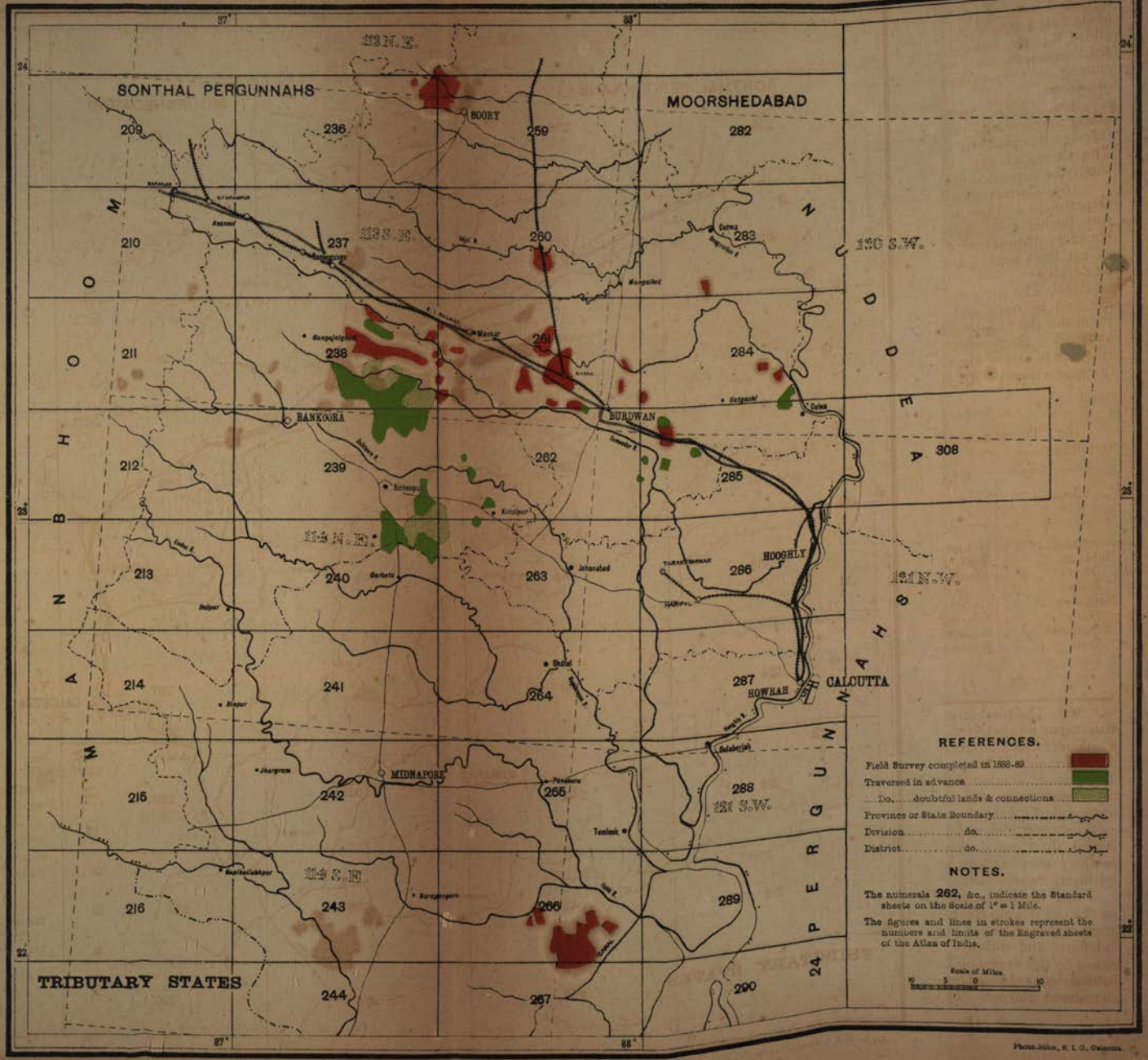


Photo-Zinco., S. I. O., Calcutta.

Reg. No. 94, S. I. D.—30-1-93.—1,000.

This procedure of course somewhat added to the expense, which was already rendered high in consequence of the scattered nature of the work; but over and above this was added the cost of local labour for chaining, which is ordinarily furnished free. Each *amin* requires four men for this purpose, and he can survey about half a square mile a month; the four men at ₹5 a month consequently added ₹40 per square mile to the average cost. This is a charge which is not incurred in the North-West Provinces, hence it must be borne in mind when making any comparison between the cost of survey in Bengal and in those provinces.

164. All the vernacular records have been made over to the Settlement officer together with one set of tracings. In July a request for two extra sets of tracings was made by the managers of the estates; these are still in progress. The sheets of 371 villages and 380 *arazis* are ready for submission and will shortly be deposited in the head-quarters office.

165. Correction slips for 65 villages were received from the Settlement Department and the necessary alterations have been made on the field sheets. Any further corrections will be made in the Calcutta office. Tracings of 66 boundary disputes were sent to the Settlement officer of which only seven have as yet been settled, and there remain besides these, 67 from last season, still to be decided

166. The party suffered severely from fever during November and December, and in April and May a terrible epidemic of cholera devastated Upper Purneah: the *raiyats* either fled or hid in their huts; the dead were often left unburied. Settlement operations were stopped owing to the refusal of the villagers to attend the Courts, but the survey was carried on to completion under the supervision of Mr. Powell.

BURDWAN KHAS MEHALS.

167. The names and areas of the Burdwan Khas Mehals as furnished were as follows:—

DISTRICTS.	MEHALS.	Areas in acres.	Area in square miles.	Area in each district.
Beerbhoom	Hukmapur	15,491	24	24
Burdwan	Sankho	4,087	6	...
Ditto	Bhedia	2,421	4	...
Ditto	Scattered Mehals	12,728	20	30
Bankoora	Hudda Rupal	4,402	7	...
Ditto	Sonamukhi and the Ghats	19,748	32	39
Midnapore	Sujamuta, &c.	25,582	40	40
Ditto	Revenue-free estates	Unknown.		
	TOTAL	84,459	133	133

168. The total area surveyed without jungle *mehâls* was 127 square miles. Hukmapur was selected for survey first of all, as it was ascertained that it lay in a compact block in a country which was likely to be fitted for immediate survey; the other *mehâls* were to be taken up in the order as given in the above table. The want of demarcation was at once felt, there being nothing to show either actual possession or the boundaries as given in the old Revenue Survey maps. To have waited till the demarcation could be made would have kept the bulk of the establishment idle, and postponed the commencement of the survey indefinitely. It was therefore decided to have traverses run along the lines pointed out by the *Raj* officials as *mauza* or *khâs* limits, leaving the adjustment of them for future consideration.

169. In Hukmapur, the traverse round the outer limits followed very closely on that of the old Revenue survey. As the work progressed, boundary disputes arose and even active opposition was threatened; actual possession was most indefinite and difficult to ascertain. Under these circumstances, notices were issued to the *zamindârs* and *patnidârs* concerned to be present to point out the boundaries as claimed by them, while the *Raj* officials pointed out those which they considered correct. The traverse lines were run between; and those interested

were informed that the land under dispute would be measured and recorded as under dispute, to be hereafter adjusted by the Settlement officer. To facilitate the adjustments of these disputes, field books of the traverse along the old boundaries were made up from the old 4-inch survey, which were then plotted on to 16-inch sheets; they were also demarcated on the ground. The interior lands were contained in 88 *mauzas*, whereas the old maps showed 103. According to instructions from the Director of Land Records the limits of these old *mauzas* were plotted on the 16-inch sheets. The limits of fields most nearly corresponding with these old boundaries were then adopted as boundaries, and lists of the numbers included within each were added to the records. In Sujamuta, the natives commenced opposing the work but were finally persuaded of the illegality of doing so; in that block the traverse lines had to be run along the *bands*, the fields being still under water. In Sonamukhi, the traversing of 98 *mauzas* out of about 150 was completed. No further work was done in that block in consequence of the hopeless confusion which prevailed there as to what were *khás* lands. In Rupal, the Revenue Survey boundaries were no guide at all as to what were *khás* lands, portions of *mauzas* being now claimed as *patni* and portions said to be *khás*. These various portions, however, were found to be fairly well grouped together and a circuit was run round them. Subsequently this circuit had to be extended to include 23 other villages which were traversed and plotted.

170. During the traverse operations, all theodolite stations were marked by buried *gharras* (pottery jars) filled with charcoal. Subsequently in Hukmapur 200 stones were embedded in the outer circuit and at selected interior points. Stones were also embedded in Sankho and Bhedia, but the number ordered at first was found to be insufficient for all the scattered *mehâls* and those ordered later were not received in time.

171. The cadastral survey and the record writing in Hukmapur and Burdwan were completed, with the exception of those of four detached *mauzahs* in "lot" Hukmapur and 63 *mauzas* or *chaks* in the other portions of district Burdwan. The *khasra* was written in Urdu as there were no Bengalis available who were capable of reading the field sheets, but the *khatians* were written in Bengali in the field; the other papers were all written in Bengali. The areas were extracted in the standard *bigha* of 1,600 square yards, as there were disputes as to the length of the *laggi* (on which local measurements are based) and the size of the *bigha*. The whole of the records of Hukmapur, and tracing of sheets was made over to the Settlement Department before the party left the field. A second set of tracings and abstract of *milan khasra* in English were subsequently supplied to the manager. In Sujamuta, the survey of all except half a square mile and the record writing of 40 villages were completed, and of 80 more the records were well advanced when the rains set in and it was impossible to carry on the work, the fields being all submerged.

172. In Bankoora immense confusion prevailed as to what was the property of the *Raj*. During the survey in 1853-56, *patnidars* registered their names for many more *mauzas* than they had a right to, but no action was taken by the *Raj*, and it is supposed that many are still in possession but pay no rent. Old lands have been abandoned and new lands broken up; the old names have been lost and new names registered that do not appear on the old maps nor in the old records, and in many cases though the names exist and the land corresponding to the names is allowed to be *khás*, the positions of such lands have been changed. A list of *khás* lands in the jungle *mehâls* supplied from the *Raj* office gave 31 names, with an intimation that there would probably be more. The sub-surveyor commenced work and traversed 98 *mauzas* and reported that there were still more. A complete list of all the *mauzas* obtained from the collectorate gave 309 *mauzas*, of which 161 were named as *patni* villages; this gave a total of 148 said to be *khás*, of which 98 and more had been found by the surveyors, leaving between 40 and 50 unaccounted for. Under these circumstances it was not considered advisable to commence the cadastral survey till something more definite could be arrived at, more especially as the land allowed to be *khás* was to a great extent forest clad, whilst nearly all the cultivation was claimed as *patni*, or under Government tenure, or in dispute in one form or another. In "lot" Rupal, the *khás* portions were cadastrally surveyed, with the exception of portions of 23 villages of which information was not received until

it was too late to attempt the final survey of them. Since June, at least 100 more *khás mauzas* have been discovered, so it is at present quite impossible to say how far the survey may yet extend. It is believed that without a complete survey of all lands purchased by the Burdwan *Raj*, at all events without a complete boundary survey, it will be impossible to discover what lands are really *khás*.

173. The following table gives the number of villages and the area surveyed in each district and that remaining for survey as far as is known at present:—

Districts.	Surveyed in 1888-89.						Remaining for Survey.					
	Traverse.		Cadastral Survey.		Records written.		For Traverse.		For Field Survey.		For Record writing.	
	Villages.	Square miles.	Villages.	Square miles.	Villages.	Square miles.	Villages.	Square miles.	Villages.	Square miles.	Villages.	Square miles.
Beerbhoom	88	24	88	24	88	24	4	2	4	2	4	2
Midnapore	75	46	75	46	40	31	...	...	...	...	21	6
Bankoora	177	121	42	9	42	9	121	64	256	175	256	175
Burdwan	49	52	41	48	34	36	43	5	63	10	69	17
Hooghly	...	...	...	...	...	...	17	4	17	4	17	4
Nuddea	...	...	...	...	...	...	1	1	1	1	1	1
Total	389	243	246	127	204	100	186	76	341	192	368	205

174. The total number of fields in the area cadastrally surveyed was 284,140, giving an average size of less than 0·3 of an acre; if only cultivated lands are taken into account, the average size would be much smaller. The records of 204 villages were written up, and those of 20 others partly so. The total cost of the operations was ₹45,725, which gives a rate of 9 annas per acre or nearly double that of the Srinagar survey; this high rate is due to delays both in starting and during progress of the work; to uncertainty as to what was to be surveyed; and to the scattered nature of the work and the distances apart of the separate patches for survey. As in Srinagar, the payment for coolie labour as chainmen and line cutters, as well as for embedding stones, formed a very heavy additional item of expenditure.*

TARAI, JHANSI AND LALITPUR DISTRICTS, NORTH-WEST PROVINCES.

No. 5 Party.

175. The work of this party lay in the North-West Provinces, and consisted of (1) the 16-inch cadastral survey of part of the Tarai district and of the Kumaun Bhábar, together with the 4-inch survey of the forest reserves in the Tarai; (2) the cadastral survey of Jhansi, with an 8-inch survey of forest reserves, and (3) the traverse survey of Lalitpur. The three sections into which, for convenience of

Personnel.

Lieutenant-Colonel J. E. Sandeman, S.C., Deputy Superintendent, 2nd grade, in charge.

Tarai and Bhábar Section.

Mr. J. Murphy, Assistant Surveyor, 1st grade.
2 sub-surveyors and 1 computer.
98 *patwáris* and others.

Jhansi Section.

Mr. T. F. Freeman, Assistant Surveyor, 1st grade.
„ N. Bedford „ „ 2nd „
3 sub-surveyors and others.
296 field surveyors and others.

Lalitpur Section.

Mr. A. W. Smart, Assistant Surveyor, 1st grade.
„ W. V. Skilling „ „ 2nd „
„ J. H. Murphy „ „ 3rd „
41 sub-surveyors and others.

* Mr. Shaw managed the survey of Srinagar both in field and recess with his usual ability, and Messrs. Berkeley, Barker and Powell all worked hard and well. The writer, C. Chatterjee, and Computers Bholanath and Ashotosh are highly spoken of by Mr. Scott.

working the party, was divided were respectively supervised by Messrs. J. Murphy, T. F. Freeman and A. W. Smart.

Survey of the Tarai district.

176. The continuation of the survey of the Tarai district was sanctioned in G. O. No. $\frac{1207}{1-8a.}$ (Revenue Department), dated 16th August 1888, at a cost of R13,000, to be expended during the Revenue year 1888-89; this survey has been proceeding at intervals since 1881, and has now been completed. The nature of the work, as explained in a memorandum by Mr. Macdonald, the Superintendent of the district, was as follows:—(*a*) The cadastral survey of a small area in *pargana* Kilpuri and some scattered villages in *parganas* Rudarpur, Gadarpur, and Bazpur, (*b*) the 4-inch survey of a large area of forest reserves, and (*c*) the *parganawar* statistics of the whole district.

177. The traverse surveyors were guided as to *mauza* boundaries by possession and by the old 4-inch revenue maps. The number of disputes was small, and they have all been settled with the help of maps supplied by the Assistant Surveyor. The theodolite stations were marked in 794 cases by stones obtained from the beds of the streams running through the Tarai, and in 218 places by clay cylinders. The stones were roughly about 18 inches long by 8 inches in diameter, and marked on the top with a cross. The linear miles of traversing amounted to 222; it was connected through that of Bhábar with several trigonometrical stations of the Kumaun triangulation.

178. The field-by-field survey covered an area of 61 square miles comprised in 58 villages, containing 14,479 fields, which gives an average of 2·69 acres per field. This has been done entirely by *patwáris*, supervised by three inspectors without the assistance of any *amins;* the cost of work on this new system shows that it is less than one-half of that on the old, and this is notwithstanding the restricted area of operation, the unhealthiness of the tract, the shortness of the field season, and the small number of *patwáris* available. This detail survey was checked by 305 linear miles of *partal* lines, of which 50 were run after the maps had been lodged in office; this gives an average of 5 linear miles of check per square mile of survey.

179. During the recess, the entire office work has been done for the first time by *patwáris* and with great success; the office was at Kichla, in the Tarai, under one inspector—an arrangement which has answered well. Off and on, 14 *patwáris* were engaged during four months in extracting areas and making tracings. With reference to this Lieutenant-Colonel Sandeman reports—"I am altogether an advocate for the *patwáris* doing as much as possible of the work at their homes in their circles. Provided they will work, and they will when they know they must, and provided there is a complete check on their work, there is no harm, but every advantage in this arrangement."

180. The eight forest reserves were divided into 32 minor circuits; but as the detail and traverse surveys had to be made simultaneously on account of the shortness of the field season, it was necessary to allow the detail surveyors to frame small blocks with the plane table on which to base the detail. These were subsequently traversed, and the details fitted into the polygonal traverses; in cases where the details required it, the transfer was made line by line, but practically the differences were small. The work was checked by re-surveys of a small portion of each block, which was compared with the original. Lieutenant-Colonel Sandeman, accompanied by the Superintendent of the district, also marched through part of the forest, map in hand, and reports that the survey appeared to have been carefully executed.

181. The compilation of the statistical statements by *parganas* has been commenced, but it will be a laborious as well as a difficult task, as the district has been surveyed in small scattered portions during the last nine years, and one *pargana*, that of Kashipur, was surveyed as part of the Moradabad district in 1873—75. Lieutenant-Colonel Sandeman, however, hopes he will be able to furnish a statement giving the names and areas of the villages by *parganas* accurately, though the areas of details of waste, of cultivation, &c., referring, as will be the case, to different years in the same *pargana*, will be of but little value for comparison.

182. The whole district has now been surveyed, mostly on the 16-inch, but a portion on the 4-inch scale only; the Superintendent is anxious to have certain

NORTH WEST PROVINCES SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DIST. TARAI AND THE BHABAR OF DIST. KUMAUN.

No. 5 PARTY.

Reg. No. 950

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villages which are now on the smaller scale re-surveyed on the larger; these villages, 51 in number, are situated partly in Bazpur and partly in Nanakmata *pargana*. It has been proposed that the old traverse data should be utilized as a basis for the detail work which would be executed and the areas extracted by trained *patwáris* under the supervision of two trained *kanungos;* but that the field-work shall be checked by *partal* lines run by professional agency, and that the passing of the areas shall be under professional supervision.

183. Of the assistance rendered him by the Superintendent, Lieutenant-Colonel Sandeman thus writes—"Our acknowledgments are due to Mr. Macdonald and to Mr. Kilbert (who was officiating in charge of the district during the field season) for the support they have invariably given us. It is a pleasure to work for officials who value our maps and statistics as they do, and who can appreciate the advantage of the educational training which the *patwáris* are receiving."

Survey of the Kumaun Bhábar.

184. The cadastral survey of the Kumaun Bhábar was sanctioned in G. O. No. $\frac{1510}{1444A}$, dated 16th November 1888. The area for survey was estimated at about 70 square miles divided amongst 324 villages. The establishment consisted of 10 Bhábar and 10 Kumaun *patwáris* and one *kanungo*, whose services were made over for the purposes of the survey by the Senior Assistant to the Commissioner of Kumaun. It was afterwards found necessary to employ four outsiders to assist some of the *patwáris* who were late in commencing; the whole was supervised by 5 inspectors.

185. The village boundaries were said to be for the most part marked on the ground, but in many cases it was found out, when the work was inspected, that there had been no demarcation, and they had been surveyed as pointed out. This was reported to the officer in charge of the Bhábar, and it was suggested to him that he should satisfy himself as to the accuracy of the survey, and should make over the old *thakbast* maps for comparison. A few alterations only were found to be necessary.

186. The cultivation being scattered over a long distance amongst the forests, it was necessary, in order to quickly obtain plots on which the *patwáris* could commence work, to traverse a village or two in each *patwári's* circle within each of these scattered portions; these villages were set up and proved on magnetic bearings. Each block of cultivation was enclosed in a main circuit traverse. They have all been connected with one another, with the Tarai traverses and with the trigonometrical stations of the Kumaun and Garhwal triangulation. Rough, uncut stones similar to those used in the Tarai were erected at the theodolite stations; of these 6,678 have been embedded. The officer in charge of the Bhábar has been asked to have them covered up with piles of loose stones or with earth as a protection.

187. Early in November, Survey classes had been opened at Haldwani for the instruction of the *patwáris*, and their training was pushed on as fast as possible. The work turned out by these men when trained was checked by 562·3 linear miles of chain lines, of which 145·4 were independent *partals*, thus giving 6·8 linear miles of check per square mile of survey. Lieutenant-Colonel Sandeman also ran check lines through the work of 6 *patwáris*, just as he happened to come across them, and he reports that their survey was of the best quality and quite equal to any he had seen done by *amins*. The average out-turn of a *patwári* was 460 acres per month. The following statement shows the total amount of cadastral survey work executed in the Bhábar district:—

Number of Villages.	Number of Fields.	Area in square miles.
331	37,294	82·6

The average size of the field is 1·41 acres, and of the village 159 acres.

188. Towards the end of April the operations were brought to a close by an outbreak of cholera; had it not been for this, the Kota block of cultivation, equal to 5 square miles in area, might have been surveyed.

189. During the recess, ten *patwáris* have been engaged at the office at

Naini Tal in tracing the maps and in extracting the areas of fields, and entering them in the new *khasras*. Six *patwáris* from Kumaun, two at a time, have also assisted. The recess work, through *patwári* agency, has all been completed, and the plan has worked most successfully. The *khasras* and tracings of 331 villages have been made over to the district officer, and the original maps have been completed; of these there are 215 on the 16-inch scale.

190. The estimated area for survey, as already stated, was 70 square miles, but 82·6 have already been completed, and an area of 60 square miles still remains for survey. The reason of this under-estimate is, no doubt, partly due to the omission of waste lands, roads, village sites, *nalas*, &c., which are intermixed with the actual cultivation; but this is not sufficient to account for the very large difference between the actual and the estimated area, and Lieutenant-Colonel Sandeman is of opinion that the cultivation of the Bhábar has been greatly under-estimated, and that no doubt in time the cost of the survey operations will be repaid by the increased revenue roll.

191. An estimate of the cost of completing the survey of the Kumaun Bhábar, amounting to 60 square miles of cultivation and 270 square miles of district forests, having been called for, Lieutenant-Colonel Sandeman has submitted one, by which he undertakes to do it for ₹22,500, without including the proportion of his own pay, the amount of which would depend on the work that he would have to superintend.

192. The Government reserved forests in the Bhábar have all been surveyed by the Forest Department on the 4-inch scale. The permanent marks on the boundaries of these forest blocks will be connected with the traverses of the Survey Department. The district forests will be surveyed on the same scale, and the forest growth will be divided into 7 different classes which have been arranged with the Forest officer.

193. In May, a sub-surveyor was deputed to make a survey of a portion of a forest boundary in the Bijnor district, about which there was a dispute between the Amangarh *zamindar* and the Forest Department. This new survey shows that the forest map represents correctly the boundary as found on the ground, and that it is the same as that demarcated at the last settlement. This is satisfactorily proved by means of two old pillars which are marked on the settlement map, and which are still in existence. But the *zamindar* points out that the distance from the threshold of his fort to the forest boundary is found by actual measurement to be more than a quarter of a mile less than that shown in the Government or Settlement map. An inspection of the new survey shows at once that the fort is not in its true position on this old map, and it is this which had given rise to the dispute. Similar mistakes are common on these old maps, and such claims might arise on all sides if the *zamindars* understood them and were capable of testing them for themselves.

Survey of the Jhansi district.

194. The cadastral survey of district Jhansi was sanctioned in G. O. No. $\frac{888}{1\cdot505}$, dated 29th June 1888, orders having been issued for the traverse survey in the previous January. It was to be conducted on a scheme elaborated by Lieutenant-Colonel Sandeman for the survey and revision of records entirely through the agency of *patwáris*.

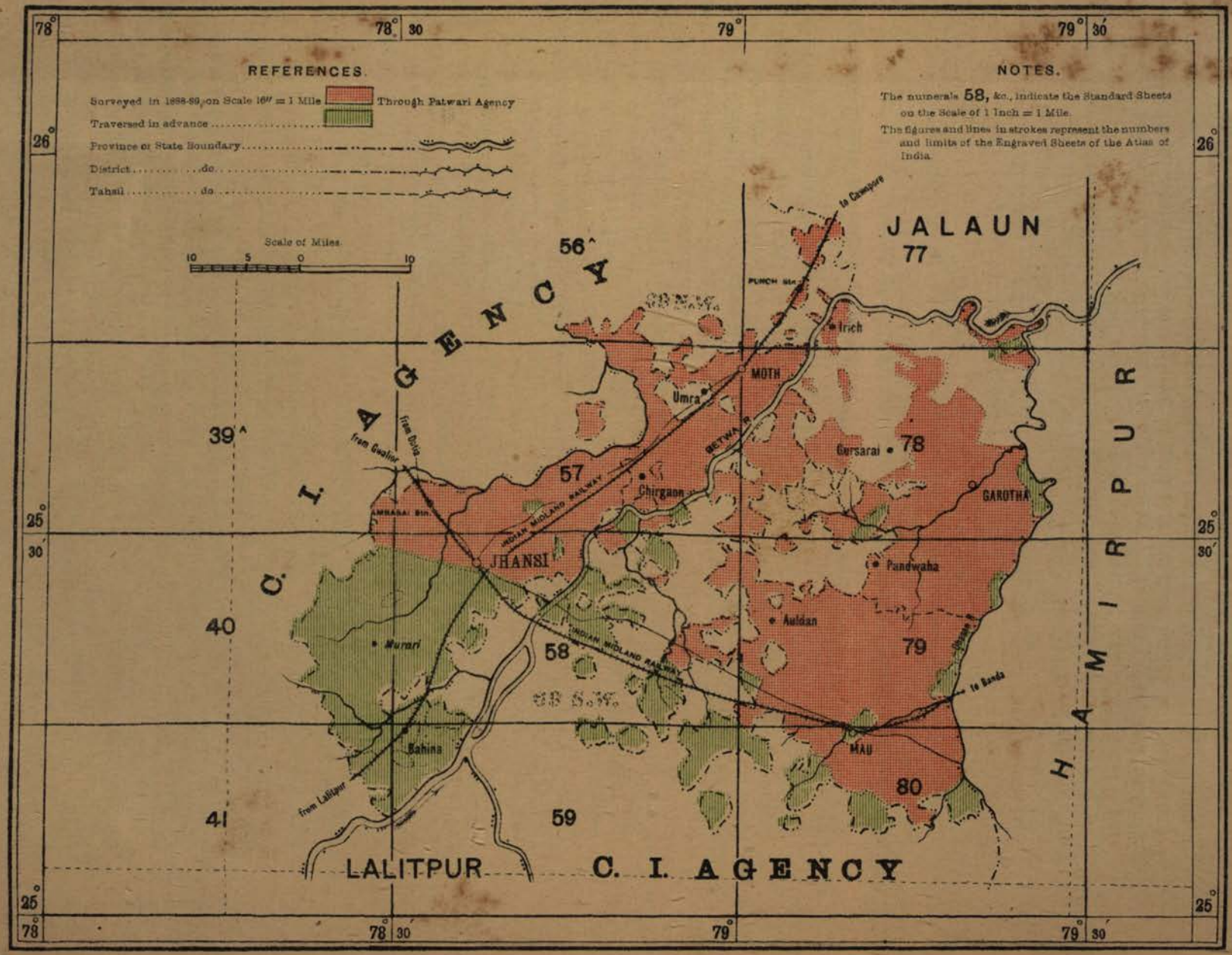
195. The traverse section took the field in the middle of October, and continued the work which had been commenced last year, when scattered portions were completed, so that there might be at least one plot available in each *patwári's* circle on which to start the cadastral survey. It was connected with the trigonometrical stations of the Budhon and Rangir meridional series. Stones were embedded at 6,949 traverse stations and they were covered over with mounds of earth to preserve them.

196. There was no general demarcation of boundaries prior to survey, but the boundary stones, which had disappeared since last settlement, were erected during survey in the presence of the *zamindars* on both sides, who have attested the maps. This has been found to work well and economically, inasmuch as there has been no separate demarcating establishment; furthermore, the villagers have been only once harassed instead of twice, and the plan has diminished the opportunities of raising boundary disputes. Again several of the disputes that did

NORTH WEST PROVINCES SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT JHANSI.

No. 5 PARTY.



Reg. No. 983, S. I. D.—7-3-90.—380.

Photo-litho., S. I. O., Calcutta.

occur were disposed of at once by the surveyors who demarcated the last settlement boundary whenever this was possible.

197. The boundaries between British and Native States are, as a rule, marked by masonry pillars, but in some places encroachments had been made between the pillars; the line, when the land was not disputed, was in these cases marked by flagstones between the masonry pillars.

198. The traversing of the Gursarai estate was also to have been done, but it has been postponed until next year on its being pointed out that under existing conditions it was not likely that the stations would be preserved; the Board of Revenue was addressed on the subject of the demarcation of the village boundaries and of the preservation of the stations.

199. Besides the traversing of village boundaries, some secondary triangulation was undertaken with a view to obtaining heights above sea-level in the Moth and Jhansi *parganas;* the heights of many stations have thus been obtained and these have been supplemented by others, chiefly at village tri-junctions, taken with the tangent scale clinometer. The triangulation will be extended over the Mau and Garotha *parganas* next season.

200. On the first of October 1888 the professional instruction of the *patwáris* was commenced at the different *parganas*, an Assistant Surveyor being sent to that of Garotha; Colonel Sandeman himself inspected the schools at the other *parganas*, and came to the conclusion that the plan of instruction was succeeding, but that in each *pargana* some 10 to 15 substitutes would be required to take the places of lazy or incompetent *patwáris*. This proved correct, for in February it was found necessary to entertain 59 substitutes; the *patwáris* who had failed to do their own work were suspended by order of the Deputy Commissoner. By the 1st December the greater number of the men under instruction were considered as qualified, and the cadastral operations were commenced; great difficulty was experienced both in the field and in recess in making the *patwáris* work: they would not exert themselves; during the field season 7 were dismissed and 47 were suspended, and their pay given to substitutes. On the completion of the survey, a list of incompetent *patwáris*, who are considered incapable of maintaining their maps, will be given to the Civil authorities, as well as a list of heirs and men of the *patwári* class who have been trained, and from whom only it would seem to be advisable to replace incompetent men. The *kanungos* and *naib* registrars were put through the same training as the *patwáris*, and 7 of them were employed in supervising the *patwáris*. Each *patwári* was confined to his own circle, and no outside agency was introduced except in the cases where the *patwáris* proved to be incompetent, or where it was necessary to give some assistance on account of the large size of the circles. With the sanction of the Board of Revenue a sum of ₹600 was distributed amongst the *patwáris* who had performed their duties well.

201. The out-turn of the season, on the 16-inch scale, in the Jhansi district is given in the following table and the cost rates thereof will be found at page 74:—

Parganas.	Completed.			Partly surveyed.			Total Cadastral Survey, with Village Records.	
	Number of villages.	Area in square miles.	Number of fields.	Number of villages.	Area in square miles.	Number of fields.	Number of square miles.	Number of fields.
Mau	139	320·0	122,579	11	33·0	20,092	353·0	142,671
Garotha	119	300·3	100,915	1	3·5	1,000	303·8	101,915
Jhansi	125	235·2	115,180	27	46·8	25,610	282·0	140,790
Moth	116	203·6	115,675	18	15·7	14,589	219·3	130,264
Total	499	1,059·1	454,349	57	99·0	61,241	1,158·1	515,640

The average size of the field is 1·44 acres. The total amount of check survey aggregated 4,106 linear miles, or 3·54 miles per square mile of survey. The area remaining amounts to 285 square miles comprised in 87 villages.

202. The recess work has been done by the *patwáris*, an office having been started at each of the four *tahsils*. The areas were extracted by the *patwáris* and checked against the results obtained by the universal theorem by the two European assistants who were in charge of the offices. The *patwáris* have also

drawn their own maps and have made tracings of them; they are now engaged in extracting statistics for the Settlement officer.

203. The survey of the reserved forests and of the Government waste lands was sanctioned in G. O. No. $\frac{145\ F.}{902\cdot2}$, Rev. (Forest) Department, dated 20th February 1889. The area was roughly stated at 46 square miles; the scale of survey was to be 8 inches = 1 mile, and the cost was to be limited to ₹2,500. The only existing maps were very rough boundary maps, said to be on the 12-inch scale, though this was not noted on the sheets, and on which no pillars were shown as they had been erected subsequent to survey; in some cases the boundaries themselves had been changed, rendering the maps of those blocks absolutely useless.

204. The following directions as to what was to be shown on the forest maps were given by the Conservator:—(*a*) all topographical details to be surveyed and mapped; (*b*) the main changes of soil to be separated; (*c*) the main features of forest growth to be separated into four different classes named by him. Scattered amongst 122 villages are 171 plots of forest land, comprising an area of 39 square miles; of these, 59 plots, aggregating 2·8 square miles, have been surveyed on the 16-inch scale, in the course of the cadastral survey, by the *patwáris*; they consist of plantations of *babul* (*acacia arabica*). A field-book boundary survey of 19 of the larger reserved forests has also been made and plotted on the 8-inch scale; it was intended to complete them all, but the demarcation was found to be so defective in many places that it was considered a waste of money to continue the boundary survey until the demarcation was completed.

205. The reserved forests in the east and north-east of the district are a mass of ravines, and it will cost a very large sum of money to survey them in detail. It has therefore been decided, if the Conservator will agree to it, to survey the main ravines and all cultivation within the ravine country, marking also the junctions of all the small ravines with the more important water-courses, but omitting all small streams below a certain minimum length.

206. A few of the hills in the Jhansi and Moth *parganas* were contoured with the cross staff on Colonel F. C. Anderson's system; this was found to be so successful that it is proposed to adopt it for all the hills in the district.

207. During the field season the senior member of the Board of Revenue, as well as the Director of Land Records, visited Colonel Sandeman's camp and inspected the work in the field, and they both expressed their approval. The Director also inspected the office at Jhansi in September, and reported that he was well satisfied with the work done by the *patwáris*.

208. The following Junior Civilians have gone through a two-months' course of instruction during the field season, *viz.*, Messrs. Molony, Hopkins, Warburton, Sabonadiere, Tudball, Penny, Rogers, and Radice.

209. Colonel Sandeman in his report thus speaks of the assistance he has received from the district officials:—"It remains for me to express my thanks to "Mr. Hardy, the Deputy Commissioner of the district, whose co-operation has "invariably been given to us. If it had not been for his support against much "indifference and opposition manifested by *patwáris* and others, success would "have been an impossibility. I have also to acknowledge the marked assistance "received from M. Khairat Ali, Tahsildar of Garotha, and from the late M. Enait "Hosein, Tahsildar of Moth, whose death is a great loss at this time, for he had "great local knowledge and influence."

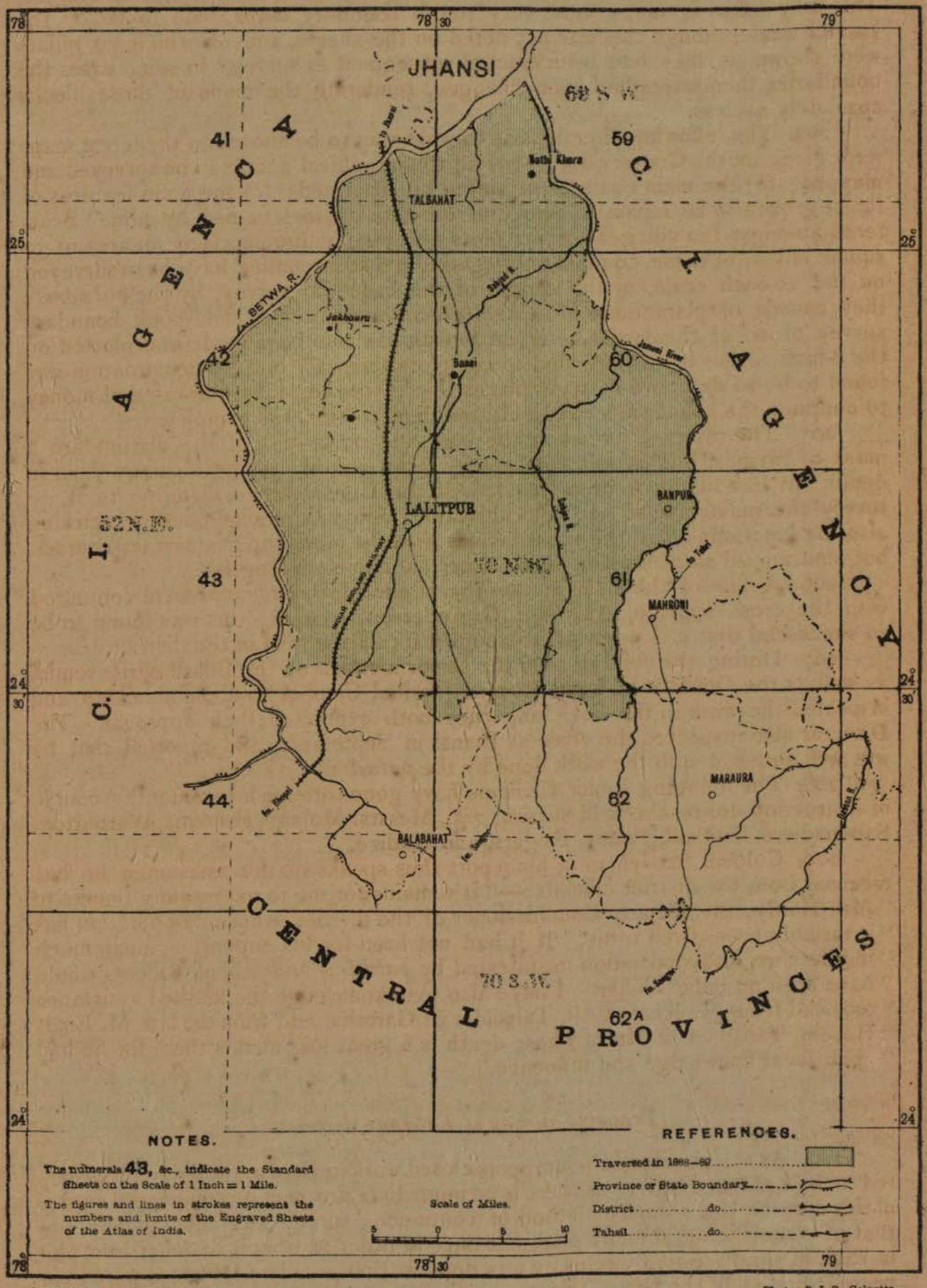
Traverse survey of Lalitpur district.

210. As the traverse sub-surveyors closed work in Jhansi, they were transferred to the Lalitpur district; as there is no immediate prospect of a cadastral survey of this district, the ordinary method of continuous survey was adopted and not that of commencing in many places at once in order to obtain at least one plot in each of the *patwáris'* circles as was done in Jhansi. The traverses were connected with 11 of the Great Trigonometrical Survey stations.

211. The platforms and flagstones, which are permanent boundary marks existing since the last Settlement, were utilized for the theodolite stations as far as possible, and in other cases, the stations have been marked by stones specially embedded; a few rocks *in situ* were also used. The newly embedded marks are uncut natural stones, 18 inches or more in length, of at least 20 seers in

NORTH WEST PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTRICT LALITPUR No. 5 PARTY.



Reg. No. 983, S. I. D.—17-3-90.—500.

Photo., S. I. O., Calcutta.

weight, and all have a cross or a triangle chiselled on them; they have been covered over with piles of stones or mounds of earth for their protection. Index maps showing the position of all theodolite stations are in preparation and will be made over to the headmen of the villages, from whom receipts have already been taken on the prescribed form.

212. The out-turn of traverse work in the district of Lalitpur is given in the following table:—

Parganas.	Number of villages.	Number of sub-traverses.	Permanent marks.		Area in square miles.
			Platforms and flag stones.	New marks.	
Talbahat Bansi Lalitpur Banpur	447	1,475	11,820	10,922	1,200
Forest reserves.	59	...			

213. The area remaining amounts to about 800 square miles, of which about 110 are in forest reserves.

214. To Mr. Short, Deputy Commissioner of Lalitpur, Colonel Sandeman says his acknowledgments are due for the assistance he has rendered him.

215. During the recess season at Naini Tal, the mapping of the 4-inch sheets of the Gandak river series, as well as the 2-inch sheets of Tarai and Jhansi, has been progressing under Mr. Smart's immediate superintendence.*

SIBSAGAR DISTRICT, ASSAM.

No. 6 Party.

216. This party commenced operations in district Sibsagar on the 10th November 1888, and continued working in the field until the 18th May 1889, when they returned to recess quarters at Shillong. On the 1st July Mr. Barrett availed himself of 3 months' privilege leave, Mr. J. H. O'Donel taking charge of the party during his absence.

Personnel.

Mr. E. C. Barrett, Deputy Superintendent, 3rd grade, in charge.
" J. H. O'Donel, Surveyor, 3rd grade, in charge from 1st July to 28th September 1889.
" J. Connor, Surveyor, 4th grade.
" M. Gastaud, Assistant Surveyor, 2nd grade.
" J. Smith, Assistant Surveyor, 2nd grade, 23 sub-surveyors and others.

Temporary Establishment.

17 field surveyors, &c.

217. The traverse survey was carried on in the three sub-divisions of Sibsagar over an area of 552 square miles, of which an area of 281 square miles is in advance for next year's cadastral operations. The *mauzas*, which in Assam correspond to the *parganas* of Upper India, have been sub-divided into village blocks averaging about a square mile in area; the existing boundaries of tea and other estates, as well as roads and natural features, have, as far as possible, been adopted as the boundaries of these new villages.

218. All village tri-junctions have been marked by stone prisms 3 feet in length with sides of one foot, sunk in the ground, and the positions of all theodolite stations are marked by branches of the *semal* tree planted at a distance of 5 feet to the

* Mr. T. F. Freeman supervised the cadastral work in Jhansi, and to his energy and good management may, to a great extent, be attributed the success of the experiment of utilising *patwári* agency entirely; the out-turn of 1,158 square miles of survey with maps, records, statistics, and tracings complete, speaks for itself. Mr. N. Bedford and the following Natives ably assisted him, *viz.*, Babu Puran Chand, M. Waris Ali, and Kurban Ali. Of Mr. A. W. Smart, who supervised the traverse section, Colonel Sandeman says he cannot speak too highly of the quality of his work and his unceasing devotion to it. Messrs. W. V. Skilling and J. P. Murphy also gave complete satisfaction.

The following members of the Native establishment are also well reported, *viz.*, Badri Pershad, Nidha Lall, Dhanput Rai, Dya Shankar, Kapur Chand, Mohamed Ismail, Bhajan Lall, Bala Pershad, Basant Rai, and Misri Lall.

magnetic north of the stations themselves. About 50 per cent. only of these branches take root, so mounds of earth, 6 feet in diameter and 4 feet high, have been thrown up around them, which secure the positions, even though the branches fail to strike. The existing boundaries of grants are occasionally marked by masonry pillars and stone prisms; and along the boundaries of *lakhiraj* and *nisf-khiraj* estates, mounds of earth and unhewn stones are often found.

219. Cadastral operations on the 16-inch scale were carried on by imported *amins* and by local agency, *i.e.*, village headmen (*mandals*) and candidates, in the proportion of 58 of the former to 101 of the latter. Of these 101 *mandals* and candidates, 45 had worked with the party in Nowgong in 1887-88. *Mandals* received one-third of the amounts paid to imported *amins*, and candidates received two-thirds; the average monthly earning of the new men was R23-7-3 and of the men during their second year was R40-12-3. The largest amount paid to an individual *mandal* in one month was R64-6-11 for 2,214 acres of work. The average monthly areas completed by the different agencies are as follows:—

By imported *amins*	3,072 acres.
„ second-year *mandals* . . .	1,939 „
„ „ candidates . . .	2,154 „
„ first-year *mandals* . . .	1,374 „
„ „ candidates . . .	1,409 „

Mr. Barrett reports that the work performed by the local surveyors has proved to be so satisfactory in every way that it is hoped there will be no occasion to import *amins* for the survey of the area remaining in the Sibsagar district.

220. The total area surveyed during the season is given in the following table:—

District.	Traverse Survey.			Cadastral Survey.		
	Number of *mauzahs*.	Number of villages.	Area, square miles.	Number of *mauzahs*.	Number of villages.	Area, square miles.
Sibsagar . .	30	549	551·93	32	627	656·99

The number of fields surveyed amounted to 369,987, their average area being 1·14 acres. The area surveyed cadastrally includes 619 *lakhiraj* and *nisf-khiraj* blocks, comprising 251 entire estates and portions of 3 others. The number of estates held rent-free and at privileged rates is as follows:—

Class of Estate.	Number.	Area in acres.
Lakhiraj (rent-free)	49	694
Nisf-khiraj (half rent)	205	2,051
Waste land grants (fee-simple)	42	26,338
„ (under lease rules)	11	2,308
Total .	307	31,391 or 49 square miles.

221. The imported *amins* write their *khasras* in Urdu, but each man was provided with a "deputy *mandal*" who simultaneously wrote them in Assamese; this latter record is called a *dagchitta*. The *mandals* wrote their own *dagchittas*.

222. The check lines run by the European assistants and native inspectors for the purpose of testing the accuracy of the cadastral work averaged about 2½ linear miles per square mile of survey; in addition to this, independent *partals* were run by the *amins* through their own work along lines indicated to them after their plans had been lodged in office. Including this the average length of check-line per square mile is 2·80 miles.

ASSAM SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT SIBSAGAR.

No. 6 PARTY.

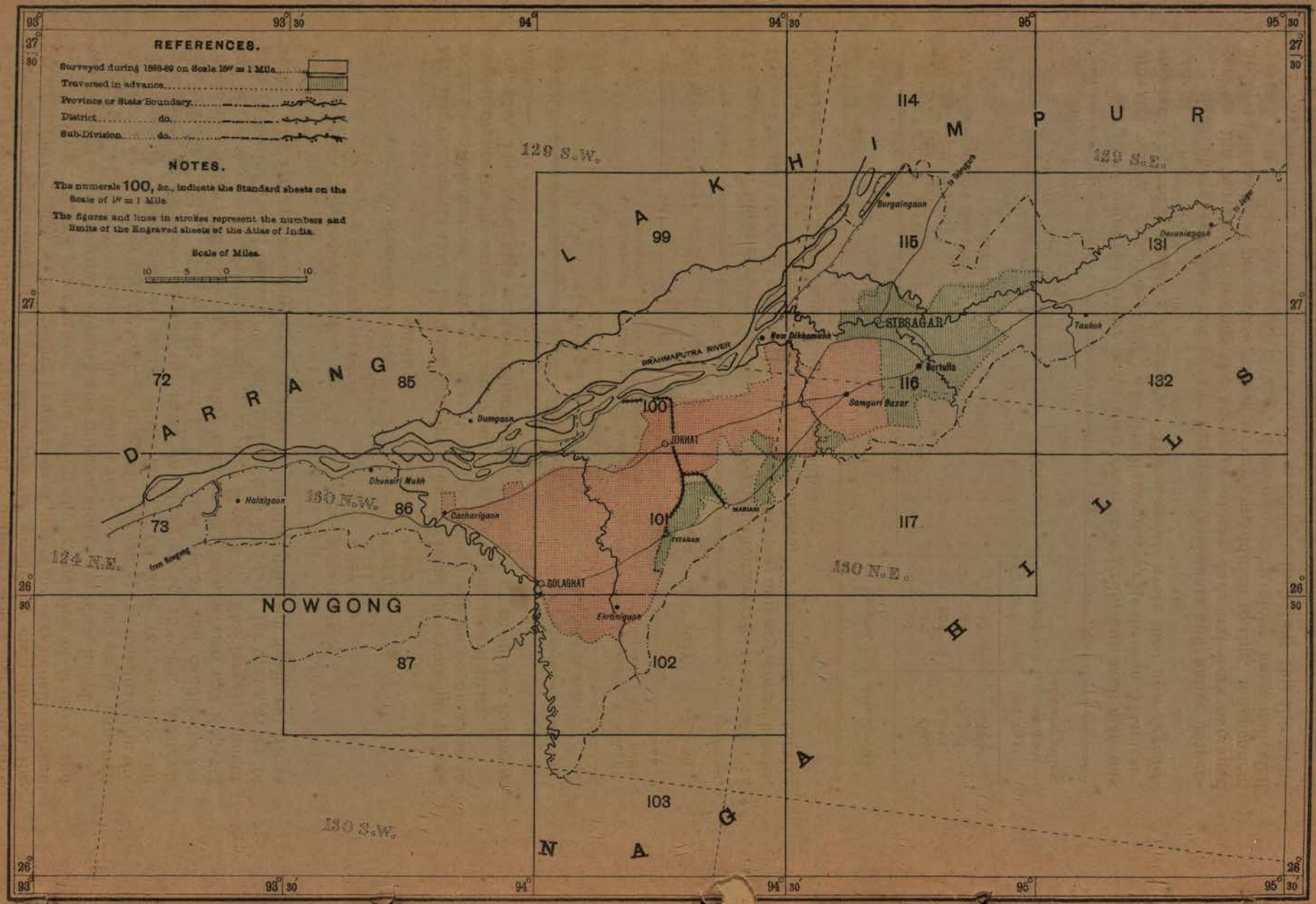


Photo., S. I. O., Cal.

223. Besides the work in Sibsagar, revision survey of the 587 square miles completed in 1887-88 in district Nowgong was carried out by 12 *amins*, each of whom was accompanied by a settlement *munsarim*. The object of this revision is to enquire into the objections which may have been made by *pattadars* to the delimitation of their holdings by the survey officials. They commenced work on the 21st October, and by 28th February it was almost entirely completed; the defective condition of many of the boundaries of the grants however necessitated the retaining of one *amin* until the 10th June.

224. The total expenditure incurred amounted to R 1,00,493-13-5, which gives a rate of R158-7-1 per square mile for all the different kinds of work, including revision survey, permanent marks, training men, and 2-inch mapping. The rate for each description of work will be found at page 74.

225. The season's out-turn is contained in 899 sheets, a tracing of each of which, together with the original *khasras* and *dagchittas*, have been supplied to the Settlement officer. It having been decided that only single copies of the maps of villages, the lands of which are either all jungle or entirely under cultivation, are required for settlement purposes, maps of villages answering this description will not be printed in future. Deputy Commissioners will be provided with single copies on tracing cloth, instead of with 50 printed copies as hitherto supplied.

226. Mr. Barrett states that he received every possible assistance throughout the field season from the Deputy Commissioner, Mr. Knox Wight, and his sub-divisional officers, Captain Henderson and Mr. Melitus. There was a show of opposition to the survey on the part of the ryots during November and December, but it gave way without the necessity of a single prosecution under the Land Revenue Regulations.

227. The health of the party was particularly good during the year, which may be principally attributed to the small number of new Hindustanis employed; most of the imported *amins* were acclimatised men who had already served two or three years in Assam.*

THONGWA DISTRICT, LOWER BURMA.

No. 7 Party.

228. This party was employed during the season in district Thongwa, but two sub-surveyors were detached to district Akyab. The traverse section took the field on the 2nd November 1888 and continued work till the 23rd May. The two cadastral sections left recess quarters at Rangoon on the 30th November and continued in the field till the 18th May.

Personnel.

Mr. F. W. Kelly, Deputy Superintendent, 4th grade, in charge.
Mr. H. R. Littlewood, Surveyor, 1st grade.
„ G. W. Jarbo, ditto 4th „
„ J. S. Swiney, Assistant Surveyor, 1st grade.
„ P. Beechey, ditto 2nd „
„ J. Haddock, ditto 3rd „
19 sub-surveyors and others.

Temporary Establishment.

175 field surveyors and others.

229. The cadastral survey in Thongwa comprised the Bawdi and Kalaung circles of the Pantanaw township (now complete); the whole of the Donubyu and Yandun townships, up to the Hanthawaddy district boundary on the east; the Wakamé, Onbin and Dedayé circles of the Dedayé township, and the eastern half of Taungbogyi circle of the Pyapon township. In Akyab district the work consisted in the revision survey on the 16-inch scale of four grants, of which the boundaries had been altered subsequent to survey, and the filling up of a gap left in the hills falling in standard sheet No. 44 during the operations of 1886-87.

* Great credit is due to Mr. O'Donel, who was in charge during Mr. Barrett's absence for the satisfactory manner in which he performed his duties. Mr. Barrett reports that Mr. Connor was in charge of the traverse section and brought his work up to date, and that Messrs. Gastaud and Smith worked hard and well. Of the professional native establishment, Mr. Barrett brings forward the following men as having done well, *viz.*, Mohan Sing, Janardhun Rao, Khairudin, Abdul Samad Khan, Vazirudin, Ganga Ram, Saroda Prosad Chuckerbutty and Andhor Chander Ghose. From amongst the cadastral hands he selects Jhuni Lal, Harak Narain, Sitanath Chuckerbutty, Bahadur Singh and Anwar Hosein as worthy of mention.

230. The traverse and detail survey areas are shown in the following statement:—

Districts.	Cadastral Survey, 16 inches to a mile.		Traverse survey.		Topographical survey, 2 inches = 1 mile, area in square miles.	Remarks.
	Number of kwins.	Area in square miles.	Number of kwins.	Area in square miles.		
Thongwa . .	265	827·18*	384	1,076	...	* Including Yandun town, 460 acres, or 0·72 square miles, surveyed on 64-inch scale.
Akyab . .	...	4·10	...	...	17·22	
Total .	265	831·28	384	1,076	17·22	

231. The cultivation comprises one-third of the area surveyed, and the areas of the separate classes of land are shown below:—

	Thongwa.	Akyab.	Total.
	Square miles.	Square miles.	Square miles.
Cultivation	264·24	...	264·24
Jungle and waste, including water .	562·22	4·10	566·32
Hills, 2-inch scale	...	17·22	17·22
Yandun town, 64-inch scale . .	0·72	...	0·72
Total .	827·18	21·32	848·50

The cultivated area includes 465,328 fields, of an average size of 0·37 acre against 0·5 of an acre last year.

232. All traverse stations, numbering 12,940, were, as usual, marked by pottery cylinders sunk nearly flush with the ground and covered over, on completion of survey, with mounds of earth for protection. The station marks of the advance traverse survey were made over to the custody of the headmen of villages who signed receipts for them on printed Burmese forms. Owing to these precautions the marks of our advanced traverse survey were preserved intact. The usual printed notices in Burmese (signed by the Deputy Commissioner) with 2-inch sketch maps entered thereon, as required by the Burma Boundaries Act, were subsequently served on, and signed by, the headmen of villages on completion of the cadastral survey. The detail survey was checked with satisfactory results by 1,287 linear miles of re-survey, of which 227 miles were done by European assistants and 1,060 by inspectors. The traverse survey was checked by 99 observations for azimuth.

233. Revision survey by the Settlement Department followed closely on the cadastral survey, and resulted in the completion of all the circles assigned for survey during 1888-89, except Tagé circle, which consists of 84 square miles in 23 *kwins*, and 30 square miles in 14 *kwins* of Thayaing circle. The revisions were for the most part confined to garden lands which had not been demarcated previous to survey. The revisions as far as completed have been entered on the cadastral sheets.

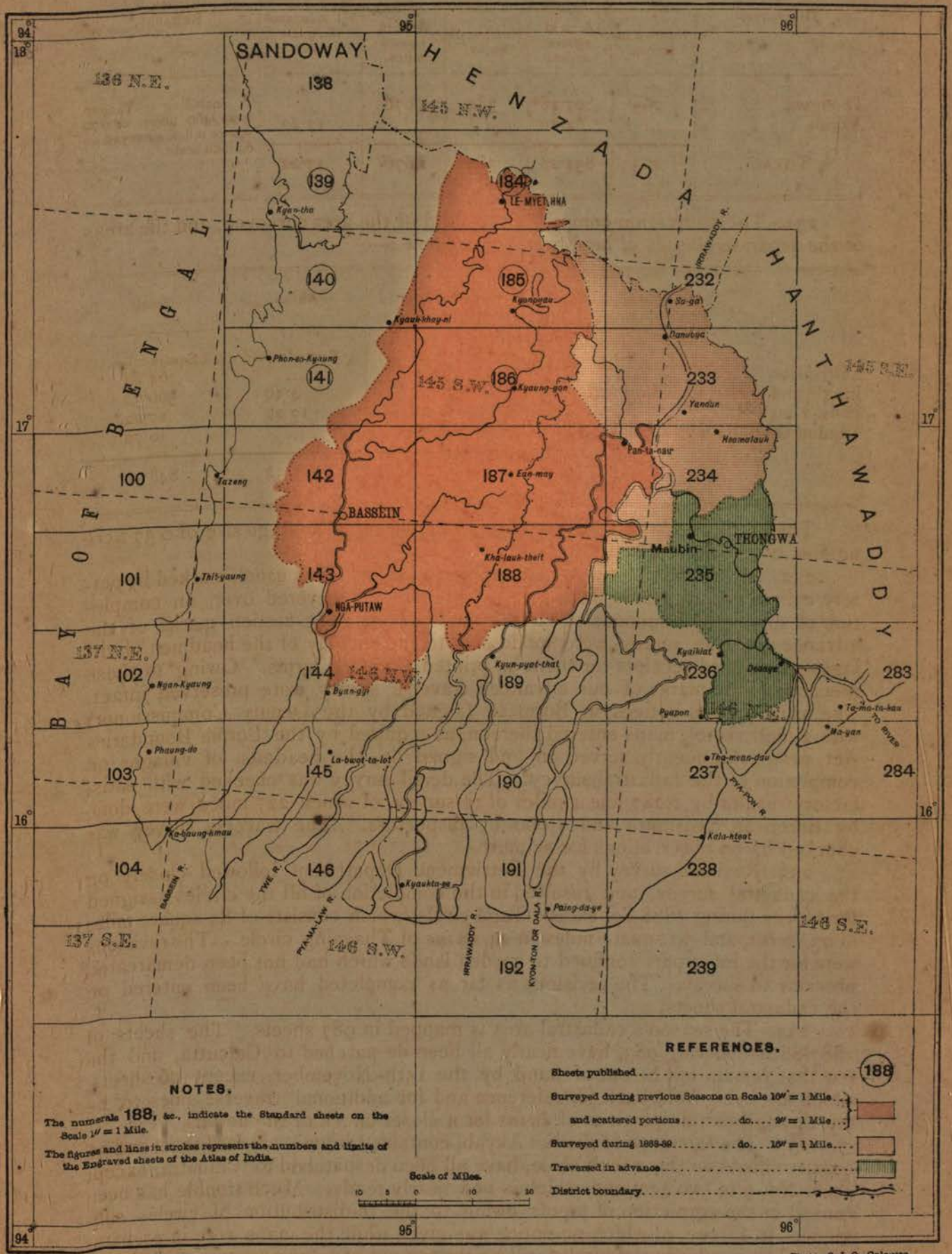
234. The season's cadastral area is mapped in 987 sheets. The sheets of 1887-88, numbering 983, have nearly all been despatched to Calcutta, and the few that remain will be out of hand by the 15th November, except 26 sheets, which are being held back for reference and for additional traverse lines to be run through certain portions of *kwins* for a closer check of the details.

235. The fair maps of district Akyab, contained in one standard sheet and 36 quarter sheets on the 2-inch scale, have all been despatched to Calcutta, except sheet No. 9 in two sections, which is now nearly ready. Much trouble has been caused in the correction of proofs owing to the re-distribution of circles subsequent to survey, of which no notice was given while the maps were in preparation. The numbering of circles will be thrown out of sequence, areas of circles will be altered, and the 16-inch maps already printed and issued will not agree with the 2-inch maps. Even the village names have been altered in some cases, differing from those supplied to the Survey by the Settlement Department, and considerable confusion is likely to be the result of these changes.

LOWER BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTS. BASSEIN AND THONGWA.

No. 7 PARTY.



NOTES.

The numerals **188**, &c., indicate the Standard sheets on the Scale 1″ = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Atlas of India.

Scale of Miles.

10 5 0 10 20

REFERENCES.

Sheets published ..... (188)

Surveyed during previous Seasons on Scale 10″ = 1 Mile ..

and scattered portions ..... do. .... 2″ = 1 Mile ..

Surveyed during 1888-89 ..... do. .... 16″ = 1 Mile ....

Traversed in advance .....

District boundary .....

Reg. No. 937, S. I. D.—4-3-90.—580.

Photo., S. I. O., Calcutta.

236. The fair maps of Bassein, in eight quarter sheets, are well advanced, and on their completion the 2-inch maps of Thongwa will be taken up.

237. The scheme for the increased employment of Burmans as field surveyors is progressing much more satisfactorily than hitherto, and during this season the Burmans, 67 in number, have for the first time out-numbered the Hindustanis, of whom there were only 47. In addition to the 67 Burman field surveyors employed, 25 apprentices were trained. During the recess, 42 Burmans were employed as tracers and computers against 32 in 1888. Out of 45 surveyors on the rolls in 1887-88, 39 rejoined; of 24 who had earned deferred pay, 21 rejoined in 1888-89; whilst 52 out of 67 earned deferred pay during this season. The average monthly earnings per man amounted to ₹30-11-10. The total of the deferred pay earned by 52 men, which is to be placed in the Savings Bank on their behalf, according to the scheme already mentioned in previous reports, is ₹960.

238. The Thongwa-Henzada boundary between the Khatko and Minywa creeks on the east and west sides of the Irrawaddy river, which had been left an open question since 1885, has now been finally settled by the adoption of a straight line between the mouths of the creeks. The discrepancies in the Thongwa-Bassein boundary have all been adjusted, except a section between Kyonkazin circle of Bassein and Hnegyo and Kyontani circles of Thongwa, which the Boundary officer proposes to deal with in November 1889.

239. The traverse survey of district Thongwa will be completed in 1889-90, and that of district Amherst will be commenced. If, as is anticipated, a cadastral area of 1,000 square miles be completed in Thongwa in 1889-90, there will remain only 400 square miles of the assigned area in the district to be surveyed in 1890-91.*

BENGAL AND ORISSA.

No. 8 Party.

240. As before, this party has been separated to work in detached sections, each section being under the immediate supervision of a Surveyor or Assistant Surveyor, whilst the whole was superintended by a Deputy Superintendent whose headquarters were located in Calcutta, in consequence of the continuance of the Calcutta city survey, of which he is the gazetted Superintendent.

Personnel.

Lieutenant-Colonel W. Barron, S.C., Officiating Deputy Superintendent, 1st grade, in charge up to 10th February 1889.
Lieutenant-Colonel S. H. Cowan, S.C., Deputy Superintendent, 3rd grade, in charge from 20th February 1889.

Calcutta Section.

Mr. D. Atkinson, Surveyor, 1st grade.
„ A. B. Smart, Assistant Surveyor, 2nd grade.
Babu Sarat Chunder Sen, Assistant Surveyor, 3rd grade, from 26th August 1889.
8 writers, computers and others.
39 field surveyors and others.

Sankarpur and Maldwar Section.

Mr. T. Shaw, Assistant Surveyor, 1st grade.
Mr. C. G. Lee, Assistant Surveyor, 1st grade, up to 30th November 1888.
36 field surveyors and others.

Kujang Section.

Mr. R. B. Smart, Surveyor, 4th grade.
9 sub-surveyors and others.
178 field surveyors and others.

Kanika Section.

Mr. C. S. Kraal, Assistant Surveyor, 1st grade, from 1st November 1888.
8 sub-surveyors and others
12 field surveyors and others.

Angul Section.

Mr. R. C. D. Ewing, Surveyor, 4th grade.
„ J. A. Higgs, Assistant Surveyor, 2nd grade, from 19th November 1888.
„ C. S. Gasper, Assistant Surveyor, 3rd grade.
5 sub-surveyors and others.
75 field surveyors and others.

241. There were five different sections engaged on independent work as follows:—the first, supervised by Mr. D. Atkinson under the immediate direction of the Deputy Superintendent, carried on the Calcutta city survey; the second, under Mr. T. Shaw, completed the Wards' estates of Sankarpur and Maldwar in Dinagepore; the third, under Mr. R. B. Smart, completed the survey of Killa Ku-

* Mr. Kelly speaks very highly of Messrs. Littlewood and Swiney in charge of the cadastral camps, and of Mr. Jarbo, in charge of the traverse camp; he also reports that Messrs. Beechey and Haddock did excellent work. He specially mentions the following members of the subordinate establishment, *viz.*, Mr. Abrew, Chein, Dakhine, Mehtab Khan, Faizulla Beg, Khoda Bux, Karim Bux, Mewa Ram, Thakhin, Hpokhin Hlat, Shoshi Bhusun Ghosal, Prionath, Mahomed Umar, Mahbub Ali, Hpokah, and Ishan Chunder Ghosal.

jang, an estate in Cuttack belonging to the Rajah of Burdwan, and commenced the cadastral work in Kanika; the fourth, under Mr. Kraal, completed the traversing of the Kanika estate in Orissa; the fifth, under Mr. R. C. Ewing, continued the cadastral survey of the cultivated village lands and the topographical survey of the jungle tracts and forest reserves in the Government estate of Angul in Orissa. Colonel Barron held charge of the whole from the 22nd October up to the 19th February 1889, when he was obliged to take furlough to Europe in consequence of ill-health: during the remainder of the season the party was superintended by Lieutenant-Colonel Cowan. The third and fourth sections in Kanika and Kujang were visited in the field by Lieutenant-Colonel Cowan, who at the same time made a tour through the two estates accompanied by the Collector of Cuttack, when arrangements were made to facilitate the survey operations, and the respective Managers were given to understand that they must render every possible assistance to the survey parties. The offices of the other sections were inspected during the recess season; the Calcutta section being at the head-quarters of the party was more immediately under the superintendence of the Deputy Superintendent.

Survey of the City of Calcutta.

242. The operations connected with this survey have been almost entirely confined to the identification of the boundaries of holdings, the drawing of the fair sheets and other office work, the field-work having been very nearly completed last year; of actual field survey, only 1·9 linear miles of traversing and 574 acres of detail survey remained, and this was accomplished.

243. It has been decided by the Government of Bengal that the boundaries of holdings in *taluk* Sutanoti are to be mapped in the same way as all the others. This *taluk* was given to Raja Nabkissen Bahadur in 1778 for a small fixed annual rental, and no attempt has been hitherto made to lay down the boundaries of the proprietors of the holdings in this estate; in many cases they themselves appear to be ignorant of how they run, so it will probably be a long and tedious task to trace them all out.

244. The investigation of boundaries and the laying of them down on the original field sheets has been entirely done by the European surveyors. As it is absolutely necessary for the validity of the boundaries which are shown on the map that the proprietors should be actually present when they are being laid down, summonses are issued appointing a fixed date and hour for their attendance; the first summons is frequently neglected, which necessitates the issue of a second as well as another visit on the part of the Surveyor. Moreover, as the proprietors have mostly to attend to their own business during the day, the hours of attendance can only be from 7 to 11; all this causes much delay, but it cannot well be avoided. In one case the Government Solicitor was asked to institute proceedings against a man who would neither attend nor give any reasonable excuse for his absence, and as this prosecution has resulted in the man being fined ₹20, it is hoped that it will have a good effect in making others more attentive in future; this is all the more desirable as the work is advancing more and more into the native parts of the city. The boundaries of 4,744 holdings have been ascertained and laid down on the map, making the total number up to date 12,980. Of disputed boundaries, 306 cases have been reported during the season, making 571 altogether, of which all except 15 have been settled by Deputy Collector Babu Kally Churn Ghose, who is an Assistant Superintendent of Survey under the Calcutta Survey Act, and who holds his Court for two days in the week in the office of the survey party.

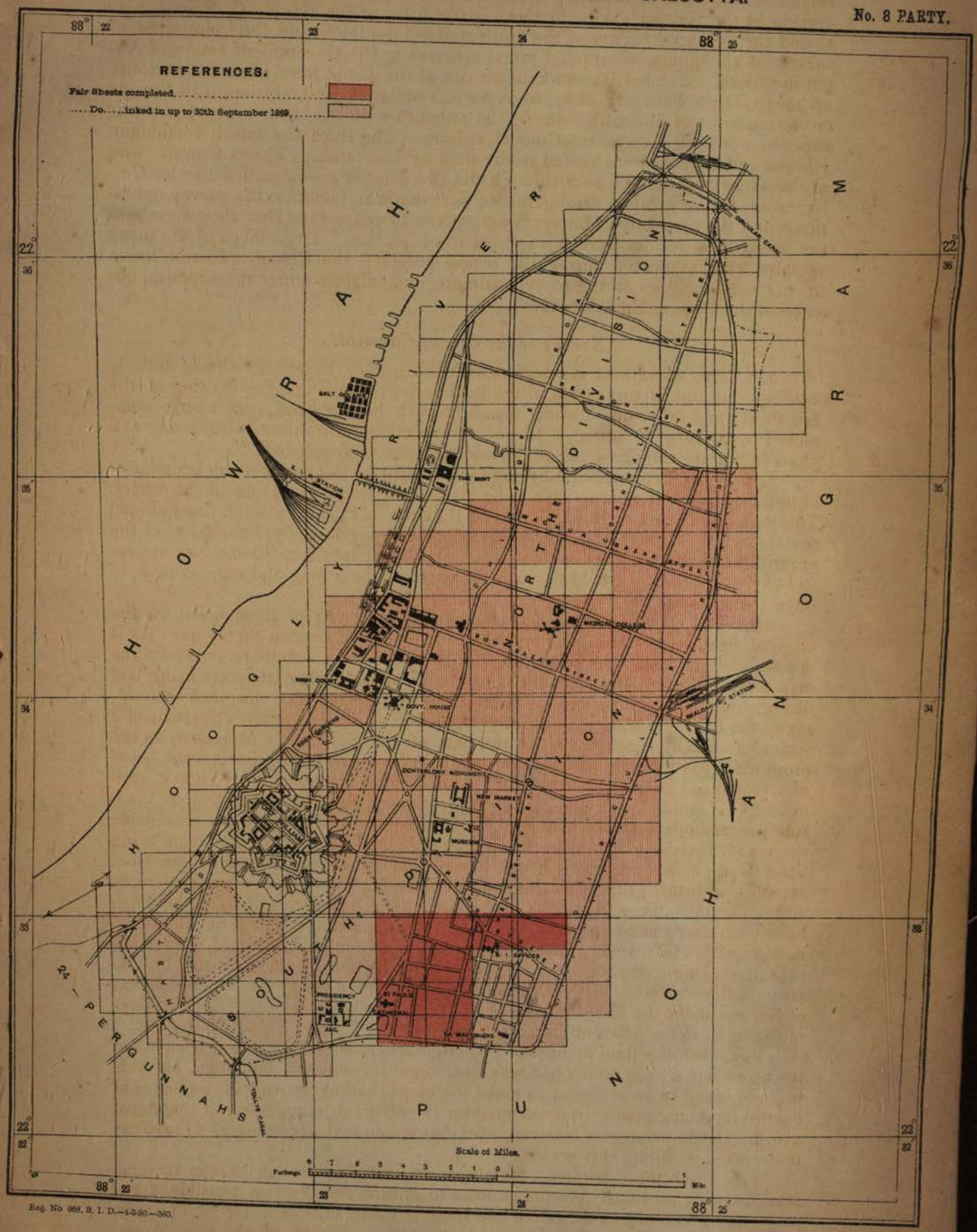
245. Out of a total number of 459 original field sheets, 454 have been inked in; up to this season colour had only been used for masonry buildings, but this was not found to be sufficient to make the maps thoroughly readable; a series of colours has consequently been selected for the different items shown on the maps, and the sheets previously inked in have been coloured accordingly, as well as those inked in during this season.

246. From these originals, fair sheets are traced at once in ink, the traverse stations being previously plotted in order to ensure the greatest possible accuracy; owing to many causes, each one small in itself, such as distortion of paper, the slight differences in the size of the squares as printed on the original and on the fair sheets, or the small errors in the plotting of the points, it is absolutely

BENGAL SURVEY.

INDEX TO THE SURVEY OF THE TOWN OF CALCUTTA.

No. 8 PARTY.



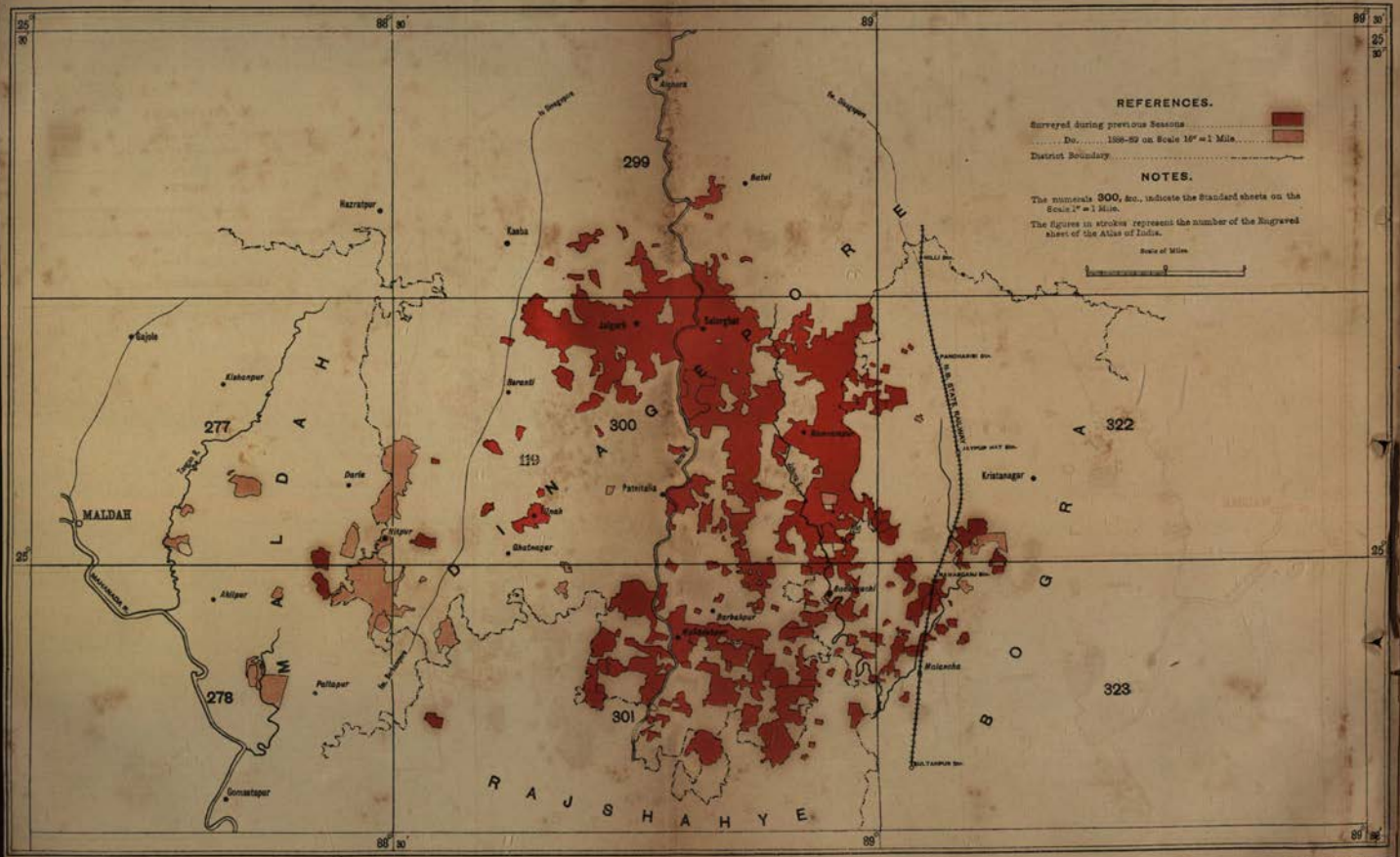
Reg. No 963, S. I. D.—4-3-90.—340.

Photo., S. I. O., Calcutta.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN THE SHANKARPUR ESTATE.

No. 8 PARTY.


REFERENCES.
Surveyed during previous Seasons
Do. 1938-39 on Scale 16" = 1 Mile
District Boundary
NOTES.
The numerals 300, &c., indicate the Standard sheets on the Scale 1" = 1 Mile.
The figures in strokes represent the number of the Engraved sheet of the Atlas of India.
Scale of Miles
299
300
301
277
278
119
322
323
MALDAH
RAJSHAHYE
BOGRA
Kazipur
Kasba
Kaligram
Salanghat
Baranti
Patnitala
Kristanagar
Kaligram
Barbakpur
Kalikapur
Malancha
Kaijole
Kishanpur
Durlo
Kaliyar
Ghatnagar
Akliyar
Pollapur
Sumastapur
Mahananda R.
Ichamati R.
Kalantar R.
Kalindri R.
Ichamati R.
Kalantar R.
Kalindri R.
Ichamati R.
Kalantar R.
Kalindri

impossible to ensure mathematical accuracy all over the sheet. The actual size of each sheet is 26″ × 18″, but an overlap is allowed so that houses, tanks and such details shall in all cases be shown complete and not be cut in two by the border line. As these maps are being prepared for photo-zincography no colour can be used on them, and the printed copies will be coloured by hand, the original field sheet serving as guides to the colourists. The total number of these final sheets will be 235, of which 124 have been drawn; very few, however, are actually ready for photo-zincography in consequence of the incomplete state of the boundaries.

247. The work remaining is still considerable, and is as follows:—

(1) The house-to-house enquiry as to names of proprietors and boundaries of buildings, of which it is believed there are still 600 remaining to be settled in the city of Calcutta and about 5,500 in the Sutanoti *taluk*, making a grand total of 19,080.

(2) The completion of the original sheets in colour, which involves many references to the spot and occasional revisions and resurveys; the insertion, however, of buildings erected since the field survey was made has now been stopped, as it was found that any attempt to do so would indefinitely postpone the final publication of the maps.

(3) The drawing of the fair sheets, of which 111 out of 235 remain, together with the finishing up and final examination of all except 10.

(4) The preparation of a register of proprietors for the Collector of Calcutta; of this the details of 7,583 have been entered, leaving about 11,500 still to be made out for the city of Calcutta and the *taluk* of Sutanoti.

Survey of the Wards' Estate of Sankarpur in districts Dinagepore, Bogra, Rajshaye, and Maldah.

248. The detachment under Mr. Shaw, which had recessed at Dinagepore, took the field on the 14th December 1888. Dinagepore is not a healthy place, and it proved to be an unfortunate selection for recess quarters, as Mr. Shaw and his establishment were unable to shake off the fever which they had contracted whilst in the field during the previous cold weather.

249. The greater number of the villages surveyed during the year were situated along the boundary line between Dinagepore and Maldah; the remainder were scattered throughout the whole of the Dinagepore district. It was supposed that the small amount of field-work remaining would be very soon completed, but on commencing it was found that there were only 5 *amins* who were willing to proceed to Sankarpur, the casualties of the preceding year having produced a scare amongst them. In addition to the difficulty of getting *amins*, there was the usual want of labour and of assistance from those from whom it might have been expected, which appears to be universal in Bengal, and which adds so greatly to the expense of survey work in this part of India; a still further cause of delay was the ignorance of the estate officials as to the position of a great many of the villages.

250. The area surveyed, which completes the whole of the estate, was 20 square miles, containing 35 villages, with a total of 12,588 fields; it was checked by 50 miles of test lines, of which 30 were run by Europeans and 20 by inspectors. Of the *khasra* entries, 1,656 were checked by Europeans and head inspectors and 1,935 by inspectors. One inspector was attached throughout the season to the Settlement officer to survey omitted *chaks*, and to render assistance in making connections in the survey maps.

251. The following statement shows the total number and area of the villages in the several districts over which the estate is scattered:—

District.	Number of villages.	Number of fields.	Area in square miles.
Dinagepore	722	207,340	260·38
Bogra	113	31,297	26·12
Rajshaye	10	2,269	1·88
Maldah	30	4,042	17·20
Total	875	244,948	305·58

The average size of the field is 0·80 of an acre.

252. All the village records have been completed and made over to the Settlement officer, whilst all the professional records and village maps have been lodged in the Surveyor-General's Office, Calcutta, where the corrections found necessary by the Settlement officer will be made.

Survey of the Ward's Estate of Maldwar in districts Dinagepore and Purneah.

253. There was but very little remaining to complete the survey of this estate, but owing to the want of assistance and in one case of resistance to the survey, it took some time to accomplish. Special difficulty was met with in a block of villages situated near the Saidpur Railway Station, and what with correspondence and the enquiries made by the Manager, no work was done in that part for two months.

254. The area surveyed was only 15·05 square miles, consisting of 36 villages, containing 31,739 fields, which completed the estate. The villages were divided about equally between the two districts of Purneah and Dinagepore. The detail survey was checked by 36 linear miles of test lines, half of which was done by Europeans and half by native inspectors. The entries of the record of rights were also tested both by Europeans and by inspectors. The records of 261 villages, covering an area of 153·6 square miles, have been furnished to the Settlement officer, but this does not represent quite the whole area of the estate; for, long after all field-work was over, the Manager sent in a list of about 72 plots of land, each of very small area, which had been omitted; it was decided that these should be measured by the Settlement officer as well as one somewhat larger block. All the professional records have been since lodged in the Surveyor-General's Office, where the corrections made by the Settlement officer will be made.

255. The following statement shows the total number of villages and area in each of the districts belonging to this estate which have been surveyed:—

Districts.	Number of villages.	Number of fields.	Area in square miles.
Dinagepore	160	125,496	94·60
Purneah	101	32,428	57·98
Total	261	157,964	152·58

The average size of the field was 0·40 of an acre.

256. During the field season the village tri-junction stones which had not been embedded during the previous year were placed in position, as well as those of the villages surveyed during the present season.

Survey of the Ward's Estate of Killa Kujang, district Cuttack.

257. The survey of this estate, which belongs to the Maharajah of Burdwan, was commenced last year, and an area of 203 square miles was traversed; no detail survey was done, nor were any men trained for it owing to the *jimbadars* (collectors of revenue) declining to attend the training schools.

258. The estate is situated in the delta of the Mahanadi river, covering an area of about 350 square miles, of which about 217 are cultivated and 133 are covered with jungle; the latter area forms a broad belt along the sea coast, in which it is impossible to carry on cultivation for want of fresh water; the heavy storms which are so common on this part of the coast also prevent this portion of the country being occupied. The traversing which remained from last year's work lay almost entirely in these jungles; the tract was divided into blocks by traverses run along the banks of the principal streams; owing to the absence of fresh water and supplies and the difficulty of obtaining coolies for line-cutting progress was slow. As the work approached completion, the surveyors were sent into the adjoining estate of Kanika to commence the traversing there, three of them being retained to complete the 4-inch detail survey of the sea coast and jungle.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN THE MALDWAR ESTATE.

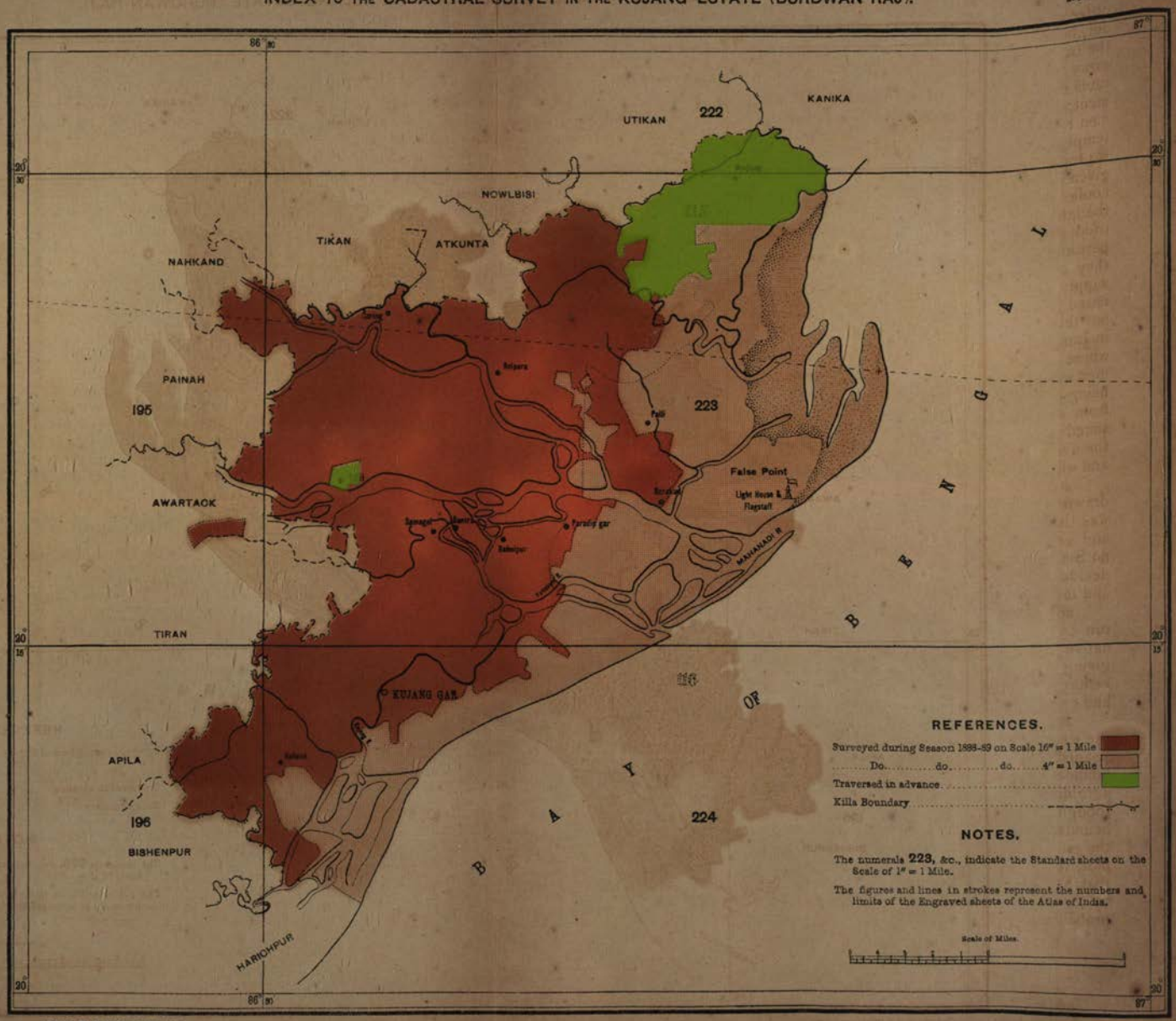
No. 8 PARTY.

REFERENCES.
Surveyed during previous Season on Scale 16" = 1 Mile.
Do. 1868-69, on Scale 16" = 1 Mile.
NOTES.
The numerals 274, &c., indicate the Standard sheets on the Scale of 1" = 1 Mile.
The figures and lines in strokes represent the numbers and limits of the Surveyed sheets of the Atlas of India.
Scale of Miles
PURNEAH
DINAGEPORE
112
118
119
273
274
275
252
297
298
Barsoi
Bhogaon
Balua
Kumarbad
Rampur
Sukan
Kaliagunj
Kumarganj
Balua
Kaliagunj
Kumarganj
Balua
Kaliagunj
Kumarganj
Balua

ORISSA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN THE KUJANG ESTATE (BURDWAN RAJ).

No. 8 PARTY.



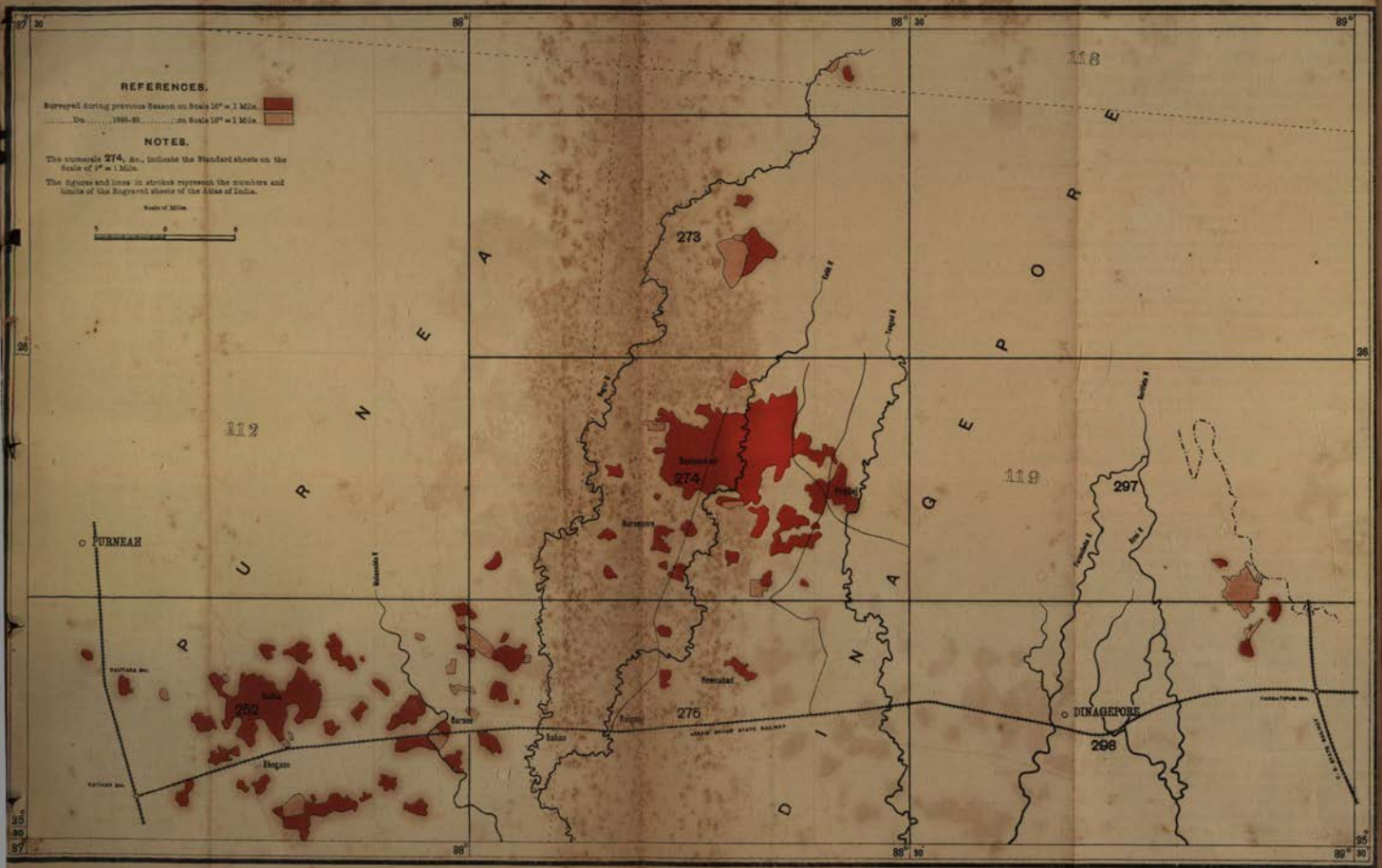
Reg. No. 28, S. I. D.—30-1-90.—1,000.

Photo-litho., S. I. O., Calcutta.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN THE MALDWAR ESTATE.

No. 8 PARTY.



259. Although nearly 200 square miles of country had been traversed last year, and cadastral work might have been at once commenced over all this area, it was not until late in the season that any attempt to start the field survey could be made. About July 1888 it had been decided that the *jimbadárs* were not to be trained, and that Urya *amins* were to be entertained for the work, and it would have been well if that decision had been adhered to. In September, however, an order was issued to train 150 *jimbadárs*, and an attempt was made to carry this out, but with very partial success. At first the men, one and all, refused to attend the training classes, and it was not until Mr. Tute, the Collector, who afforded every assistance to the survey party, issued a notice that, if they or their substitutes did not present themselves, they would be disqualified for future employment, that about 120 pupils were obtained. About the middle of December, 99 men had made sufficient progress to allow of their commencing work, and an attempt at a start was made, but they all declined to work on the terms offered, *viz.*, R4 for every hundred acres, finding their own coolies, which had been the rate given in Bánki; the rate was then altered to R9 per 100 acres, supplying their own coolies, or R2-8 per 100 acres, coolies being found for them; they all accepted the latter rate. The question of rates having thus been settled, other tactics were tried, and a deputation from the more influential men was sent to Burdwan to petition against the survey being made at all; having found this was of no avail, they commenced obstructing the work in petty ways, such as preventing the supply of coolies. Besides the 99 men alluded to above, 18 men had been nominated as substitutes by *jimbadárs* and had been trained, making a total of 117; but this number was quite inadequate to complete the survey and records. At last, in January 1889, permission was given to entertain Uryas for the survey of villages where *jimbadárs* would neither work themselves nor provide substitutes, and 120 men were taken on, but it was then too late in the season to allow of the whole area being completed, though the men were kept late in the field and suffered severely from sickness in consequence. The amount of cadastral survey completed consisted of 420 villages, containing 157,807 fields in an area of 199 square miles; the average size of the field was 0·81 acres. An area of 18 square miles remains and will be surveyed next year. The 133 square miles of jungle was all completed.

260. The forms of *khasra* and of other village papers which had been drawn up last year for Bánki were used in Kujang. The unit of measurement was the field—a piece of land of one class, in the occupation of one cultivator and enclosed by one continuous boundary. It was unfortunate that there was no Settlement officer to give orders as to how entries should be made and to decide disputes, more especially when the claims to *lakhiraj* lands became more and more complicated.

261. Test lines, aggregating 151 linear miles through 388 villages, were run by Europeans, and the entries of 10,532 fields were checked by them; the native inspectors ran 924 miles of check survey and tested 34,455 entries, giving an average of 5·4 linear miles of check survey per square mile and a percentage of 28·5 of the *khasra* entries. The 4-inch work having been all traversed, and consequently proving itself, did not require *partalling*.

262. The tri-junctions of villages have been marked with blocks of laterite, the ends of which were made triangular; for the theodolite stations, square-headed stones were used. There no was demarcation, or practically none, and the boundaries shown were those pointed out to the traverse surveyors; many of them were disputed by the *jimbadárs*, who would not attend on the traverse surveyor, though ordered to do so by the Manager of the estate; but as there are no old boundaries to be adhered to, there having been no previous revenue survey of the estate, the Collector gave orders that the boundaries, as shown on the traverse plot, should not be altered unless the sub-manager and surveyor were of opinion that actual hardship would ensue. The exterior boundary has been demarcated by the officials of the estate without consulting the adjacent proprietors, and it is probable that other disputes besides those now in existence may arise.

Survey of the Ward's Estate of Kanika, Orissa.

263. This estate, which covers an area of about 434 square miles, is situated on the sea coast, and is in many respects similar to the neighbouring estate of

Kujang; here also a broad belt of jungle runs along the sea coast protecting, in some measure, the interior cultivation from the devastating effects of the frequent gales and their attendant storm waves.

264. About the middle of December 1888, the traversing was commenced; at first there was great difficulty in procuring local labour for chaining and for line clearing, but this was soon overcome by the good arrangements of the Manager. Rapid progress could not be made until the traversing in Kujang was finished, and the surveyors from there could be transferred to Kanika. Then, again, in May work was almost put an end to by stormy weather and by a severe epidemic of cholera; it was consequently not till the 17th June that the traversing was completed and the men could go into recess at Cuttack.

265. A commencement of the detail survey was made, but only 16 square miles could be finished. Training classes had been started at the end of December, but it was not till the first week in March that nearly 130 out of a total of 230 of the *mustajirs* or rent-collectors were fit to begin working. At that time 53 plotted sheets were ready, but they unfortunately comprised villages where fresh water was with difficulty procurable and from which no *mustajirs* had come to be trained, and the men from the other parts of the estate objected to working in these tracts away from their own homes. Some were at length induced to go to work, but the results were small and it became evident that the estate would never be finished in one season if it depended on local agency entirely, so permission has been given to supplement them by Urya *amins*, under conditions which will ensure the training of a sufficient number of *mustajirs* for future extension and revision of surveys.

266. The traversing was greatly facilitated by the temporary demarcation of the village boundaries under the order of the Manager; marks consisting of mounds of earth, 3 feet in height with bamboo stakes in the centre, were placed at the bends by the *mustajirs* or by the headmen of the villages. The permanent marks consisted of blocks of laterite 3 feet long for the tri-junctions, and of stone prisms 2½ feet long, or baked clay cylinders, for the theodolite stations; the tri-junction marks were supplied by the Manager, the others by the survey.

267. The area still remaining for survey in Kanika is believed to be about 279 square miles of cultivation and 65 square miles of jungle; the latter will be done on the 4-inch scale.

Survey of the Government Estate of Angul, Orissa.

268. The Angul section commenced field-work on the 15th November 1888 and returned to the recess quarters in Cuttack on the 1st May 1889. The programme consisted partly of cadastral work on the 16-inch scale in the cultivated lands, and partly of the topographical survey of the forest and waste lands on the 2-inch scale; during the previous season the survey of these lands had been commenced on the 4-inch scale, but by order of the Bengal Government, No. 2138—382, Forests, dated 6th July 1888, the scale was reduced. The cadastral survey was made by *subarakars* (collectors of village revenue), who had been trained during the previous season; the topographical survey was carried on by Mr. Higgs and a staff of sub-surveyors.

269. The total area of cadastral survey done during the season was 177 square miles nearly; the cultivated portions surveyed by the *subarakars* was carefully checked and the work was found accurate, only portions of three villages having to be rejected. The check lines aggregated 469 miles, of which 206 were run by Europeans and the remainder by the native inspectors. As in the previous season, it was found that the *khasra* entries were by no means as carefully made as the field survey, and the records sent in could never be accepted without a very strict examination. In some cases the *subarakars* recorded their own or their relatives' names as tenants of fields, which they knew were in the tenancy of men who, in some instances, were too illiterate or in others were too negligent to attend to their own interests. In some case the *khasras* had to be entirely rewritten. They were checked by the examination of 20,993 entries by Europeans and 11,975 by the native inspectors, which makes an average of 30 per cent. on the whole number. The *subarakars* were paid at a contract rate of ₹3-12 per 100 acres and out of this they had to provide their own labour.

ORISSA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN THE KANIKA ESTATE.

No. 8 PARTY.

NOTES.

The numerals **221**, &c., indicate the Standard sheets on the Scale of 1″ = 1 Mile.

The figures in strokes represent the number of the Engraved sheet of the Atlas of India.

Scale of Miles.

5 4 3 2 1 0

REFERENCES.

Surveyed during 1888-89 on Scale 16″ = 1 Mile

Do. do. on Scale 4″ = 1 Mile.

Traversed in advance

District boundary

Killa do.

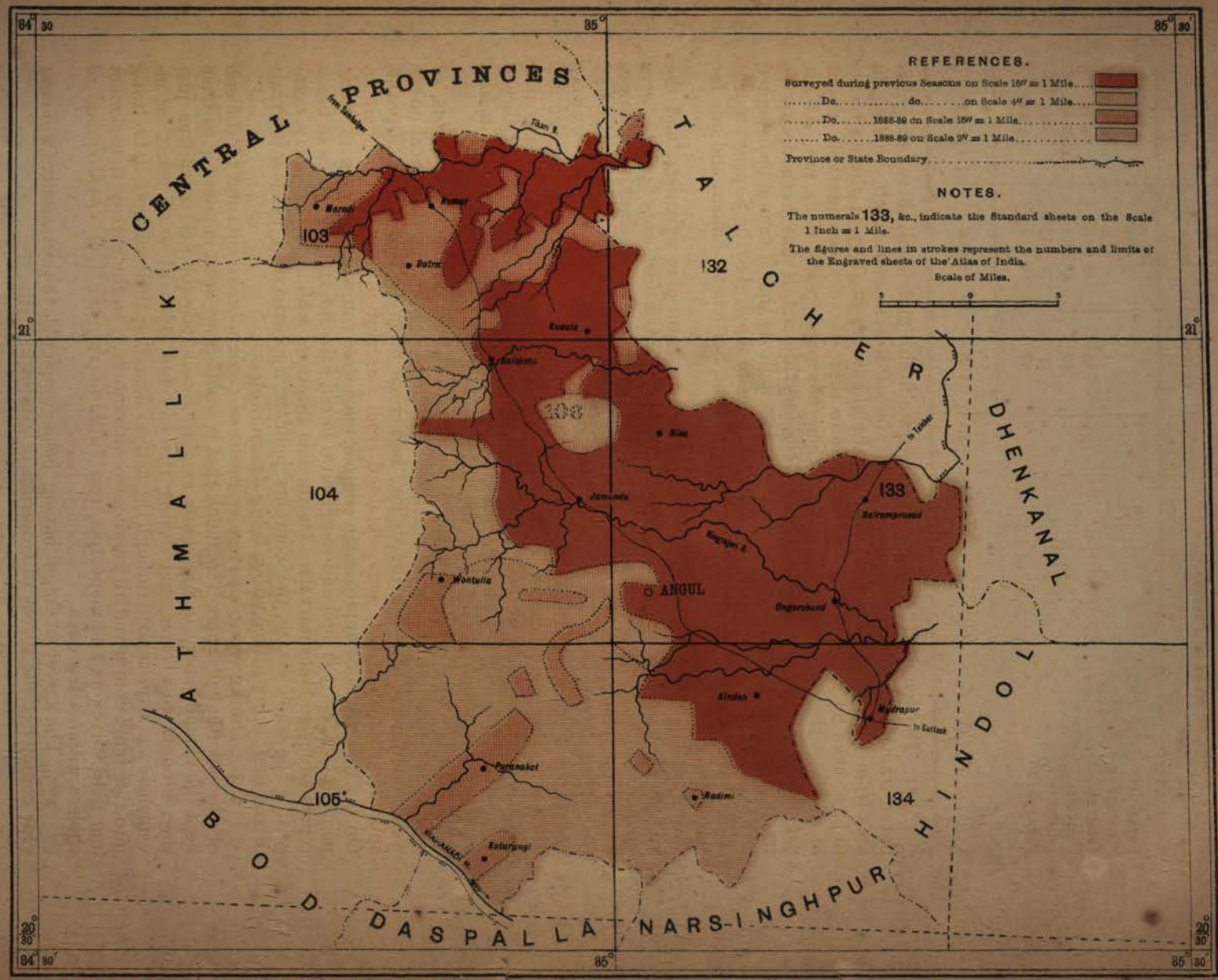
Reg. No. 999, S. I. D.—10-2-90.—1,080.

Photo.-litho., S. I. O., Calcutta.

ORISSA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN THE ANGUL GOVT. ESTATE.

No. 8 PARTY.



Reg No 933, S. I. D.—10-9-90 500

Photo-litho., S. I. O. Calcutta.

270. The following table shows the amount of cadastral work done in Angul during the season :—

Name of Pargana.	Number of villages.	Number of fields.	Area in square miles.
Tarasbisi	2	2,391	1·57
Puruagarh	1	402	1·30
Tindesh	5	6 628	3·70
Uperbisi	70	43,682	148·83
Tuinsi	30	6,725	6·73
Tikarpara	57	10,434	14·44
Total	165	70,262	176·57

271. The external boundary of the estate is still undefined, there being disputed tracts of jungle and forest lands on the north-west and south, varying in area from 1 to 20 square miles. During the old survey in 1853-54, there appears to have been no proper demarcation, and now there is very considerable doubt as to where the boundary, as shown on these old maps, really does run. At the suggestion of the Superintendent of Tributary Mehals, it has been drawn on tracings from the new maps in broken lines to indicate that it cannot be accepted as final, and three copies of these tracings have been supplied to the Superintendent of Tributary Mehals, one for himself, one for the Settlement officer, and one for the Deputy Conservator of Forests.

272. The theodolite stations were marked by burnt clay cylinders, and the village tri-junctions by laterite moulded in form of 2 feet cubes; they were erected and paid for by the villagers. This was not a satisfactory arrangement; the contractor sent in false returns as to the number of marks he had placed, or they were said to have been destroyed; at all events they were not there when the survey commenced, and delay was thereby occasioned. Moreover, they were expensive and at least of only a temporary nature, and it is doubtful whether many of them will be forthcoming at the time of the next survey and settlement. It is a pity that stone prisms were not used for all the marks as stone was easily procurable in the hills.

273. The total area surveyed on the 2-inch scale was 284 square miles, of which 215 were in the forest reserves. Heights of all trigonometrical points were determined with the theodolite; numerous other heights on small peaks, spurs near streams, &c., were obtained from observation with the clinometer. On the field sections approximate contour lines were run with the help of these points at every 300 feet and were drawn in red; the intermediate lines in black representing 50 feet intervals. On the fair sheets, of which there are 17 comprising the whole estate, the contours indicate approximately vertical intervals of 100 feet, every fifth contour being drawn in dots.

274. During April, a severe epidemic of cholera broke out, and by the end of the month had spread so much that it would have been impossible to have kept the establishment in Angul any longer; fortunately the field-work was just then brought to a close, but during the last few days of work great inconvenience was experienced through the natives deserting their villages and retiring into the jungles to avoid all intercourse with others. In the survey detachment four field surveyors and inspectors, two *burkandazes*, and four *khalásis* died of cholera within a few days.

275. The survey of Angul having been completed, the detachment will next year commence the survey of Government estates in Puri.

Survey of Killa Bánki, district Cuttack.

276. Though the field-work of this estate had been completed during the previous year, there was still some surveying to be done connected with certain disputed boundaries, all of which have not even yet been decided. Owing to this there are still five villages, of which the records cannot be completed; the papers of ten villages were furnished to the Settlement officer. The 16-inch sheets are being completed and the 4-inch mapping is making good progress; all the maps will be ready for deposit in the Calcutta Head-quarters

office as soon as the correction slips have been received from the Settlement officer and the necessary corrections have been made.

277. The boundary dispute above alluded to is between Bánki and Athgarh. A map was made for the Collector of Cuttack by joining up the old 4-inch sheets of 1837-40 as accurately as possible, and the boundaries as shown on this map were compared with those now claimed, but it is impossible to reconcile the two. Even the tri-junctions are all changed, and, in the absence of any mark common to the two surveys that can be satisfactorily identified, it is impossible to make a comparison. There appears to be no prospect of any settlement of this dispute.*

CHITTAGONG DISTRICT, BENGAL.

DETACHMENT.

278. This detachment was formed in Calcutta, principally by the transfer of men from No. 2, 10 and 4A Parties, and was placed under the charge of Mr. W. J. O'Sullivan, who had been acting in charge of No. 4A Party. The seat of operations was Old Thana Ramoo in district Chittagong, and the area was said to be about 180 square miles, of which 100 square miles were supposed to be cultivated, and the rest hilly and covered with jungle. The work required to be done was a cadastral survey on the 16-inch scale of the cultivated tracts, together with the preparation of the village papers constituting the record of rights, and a 2-inch survey of the hilly country. As the entire area, including the jungle, had been divided into villages, all the large streams therein have been traversed and mapped on the 16-inch scale, the hill sketching only remaining to be done on the 2-inch scale.

Personnel.

Mr. W. J. O'Sullivan, Surveyor, 3rd grade, in charge.
„ C. G. Lee, Assistant Surveyor, 2nd grade, from 1st December 1888.
9 sub-surveyors and others.

Temporary Establishment.

30 field surveyors and others.

279. As it was desirable to do the detail work as much as possible by means of local agency, the number of imported *amins* was reduced as much as was considered advisable, with due regard to the necessity of having a nucleus of trained men for the purpose of instruction, and to the fact that newly trained men work slowly, and that if their efforts alone were depended on, the expenditure would be unnecessarily heavy. It was decided that 7 inspectors and 47 experienced *amins* would be a suitable number to employ; of the inspectors, 4 accompanied Mr. O'Sullivan early in November 1888, in order that they might at once commence the training of local *amins*, whilst the remainder were to join in the third week of December, when some traversing had been completed and plots were ready on which to start the detail work. The traverses were to be undertaken by experienced sub-surveyors, with a sufficient staff of *tindals* and *khalásis*

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* Mr. D. Atkinson, in charge of the Calcutta Survey Section, has performed his duties with energy, and with great credit to himself; besides his ordinary daily office work he enquired into the boundaries of holdings in the early morning, weather permitting, for nearly every working day in the year. Mr. A. B. Smart, who was also attached to this section, did his share of similar work satisfactorily, and supervised the colouring of original maps and the drawing of the fair sheets. Mr. T. Shaw, who supervised the survey of Sankarpur and Maldwar, is very favourably reported on by the Deputy Superintendent, who writes thus:—"I have the honour to suggest that Mr. Shaw's good service should be brought to the notice of Government. He is an officer of exceptional ability, and his conduct of the operation in Sankarpur and Maldwar show him to be possessed of very great energy and determination. Few others would have stuck to the work and brought it to a successful conclusion as he has done in the face of opposition on all sides, a thoroughly bad establishment, disheartening criticism, and his own frequent prostration from fever."

Mr. R. B. Smart, in charge of the Cadastral Section in Kujang and Kanika, in spite of great sickness amongst his men, from which he himself more than once suffered, and in the face of great difficulties thrown in his way by the natives of the country, succeeded in very nearly completing the survey of Kujang and made a commencement in Kanika: these results are due to his good management and energy.

Mr. Pyster, a supervisor, has practically performed all the duties of an Assistant Surveyor, and has been highly reported on for his industry. Of the Native surveyors and computers, Mr. R. B. Smart mentions Shaikh Abdulia, Hyat Bux, and Manohar Lall, as having done good work.

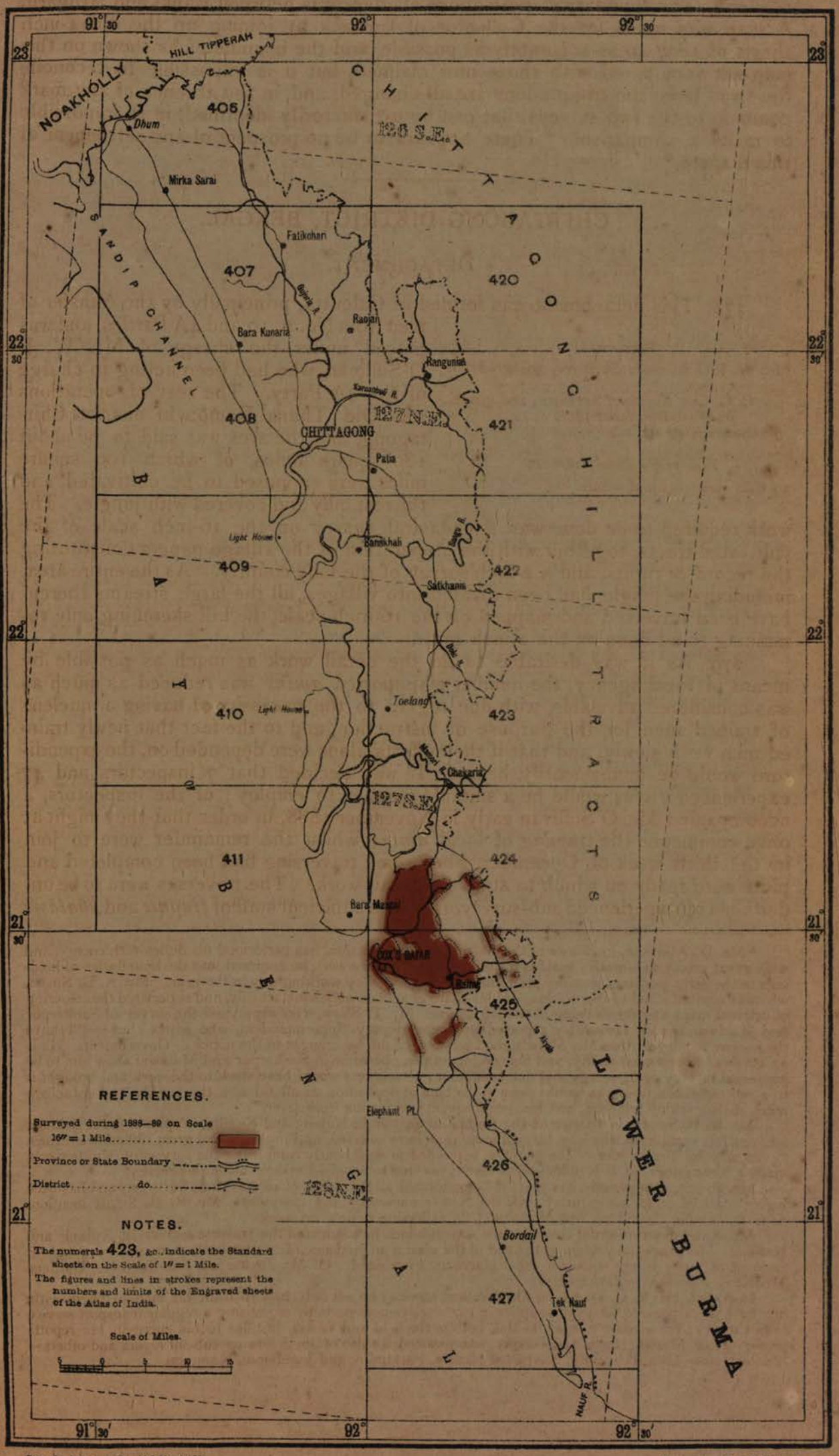
Mr. Kraal deserves great credit for the way in which he conducted the traverse section in Kujang and Kanika. More especially when at the end of the season an epidemic of cholera broke out, necessitating the removal of many of the squads to other places until it abated. Of Mr. Hickie and Sub-Surveyor Gurdeen Mr. Kraal reports very favourably.

In Angul, Mr. R. C. D. Ewing did excellent service; he not only had to train his men to begin with, but he had to provide for their supplies in the more remote parts by organising a regular transport service from Cuttack; the amount of work he did, both in the field and recess, testifies to his energy. He reports favourably of Messrs. Higgs and Gasper, who assisted, as also of the following sub-surveyors and others—Madhu Sudan Dutt, Ikbaludin, Sakhawat Hosein, Faridudin, and Jogobundo Kanungo.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT CHITTAGONG.

CHITTAGONG DETACHMENT.



REFERENCES.

Surveyed during 1888—89 on Scale 1/2" = 1 Mile.....

Province or State Boundary .....

District ..... do. .....

NOTES.

The numerals **423**, &c., indicate the Standard sheets on the Scale of 1" = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Atlas of India.

Scale of Miles.

0 5 0 5 10 15

Reg. No. 949, S. I. D.—10-2-90.—1,080.

Photo.-litho., S. I. O., Calcutta.

transferred from the other parties; but on being informed by the Collector that local labour could be obtained at R8 per man *per mensem*, the number of the menials was reduced to about 30 only. The Collector also stated that he could get together 90 men, if necessary, who had worked as *amins* under the Settlement officer during the last settlement, and who already had a small knowledge of surveying; the number of imported *amins* also was, in consequence of this, reduced to 20.

280. This reduction of imported labour proved to be a source of great trouble and delay and caused a corresponding increase of expenditure. On arrival at Cox's Bazaar, where an office hut and lines had been built, it was found that it was impossible to obtain the services of a single *khalási* under R10 a month, and 24 men had to be enlisted at this very high rate in order to make up the squads for traversing. Shortly after commencing, these men objected to line-cutting, and gave notice that they would leave as soon as they had worked off the advances that had been made to them. An attempt was then made with the Maghs, fifteen of whom were enlisted, but they proved to be even less amenable, never showing themselves until 9 A.M., and leaving off work at 4 P.M. At Mr. O'Sullivan's urgent representation, 70 men from Hazaribagh were despatched, arriving at Cox's Bazaar on the 27th December. The arrival of this reinforcement had a most salutary effect, enabling the officer in charge to discharge the discontented men on R10 a month and to engage others, when necessary, at R9.

281. At first it appeared as though the training of local *amins* would be as great a failure as the attempt to employ local menials. In November, 20 men presented themselves at Cox's Bazaar for appointments, and stated that they were well up to the work, though they could not produce any certificates; they one and all refused to be instructed, and they also objected to working on contract rates. After the departure of these men 7 others appeared, but they also objected to receiving any instruction; on being given some work to do, they all, with one exception, failed hopelessly, and their services were dispensed with; they refused to be controlled by the inspector placed over them, and they would not commence work before 10 A.M. and closed again at 4 P.M. It was not until Mr. Slack, the officiating Collector, issued an order in March, insisting on the attendance of men to be trained, that they began to present themselves. During the months from April to July, 110 men obtained certificates stating that they had attended the class.

282. The arrangements for demarcation were very defective. The Collector had sent out 15 *amins*, and the Settlement officer had issued instructions to them which, had they all been carried out, would have left nothing to be desired; but too short a time was allowed for these instructions to be matured, and the result was that the surveyors, when attempting to run the traverses, reported that they could not follow the boundaries owing to the few marks that had been erected, and they could get no information from the villagers. Rough sketches of the run of the boundaries and the names of the *matbars* and *chokidars* who had attended the demarcation *amins* were then obtained, and with the help of these the boundaries were at last traced.

283. Another source of delay was the identification of the *Maghi daghs*, or plots of the survey made in the *Maghi* year 1200. The only written information on the subject were descriptions giving length, breadth and areas, together with the bearing of each plot. Mr. O'Sullivan suggested that the field survey should be completed first, whereby the salient points noted in the descriptions of the plots would, if still in existence, be marked on the maps, and from these the *daghs* might be recognised by a process of following on from one to another. After considerable delay and much argument, this plan was adopted, and in March, a commencement was made; at first fixed salaries were given to the surveyors, but it was soon found that the men spun out the work to the utmost, and the daily average was only about 8 *daghs* identified. A Hindustani *amin* was then instructed in what was wanted, and a Bengali *mohurrir* was given to him to read the descriptions, and after a week's practice he identified from 80 to 100 *daghs* daily. A contract price per hundred was then fixed.

284. The traverse work was brought to a close on the 25th March. It had been an arduous task on account of the hilly nature of the country and the heavy jungle that covered a great deal of it. The slopes of the hills were so short that the inclination had often to be recorded more than once in each station; the

difficulty of seeing long distances necessitated short lines, whereby the number of stations and angles were increased and the surveyor's time, owing to the defective demarcation, was much occupied in finding out where the boundaries ran.

285. All the tri-junctions of villages, 102 in number, have been marked by stones; as the traversing was started before the arrival of these, the theodolite stations were temporarily marked by 18-inch pegs with a 2-inch nail at the top of each. Two parties were subsequently sent out and marked 314 stations with stones and 700 with baked clay cylinders. The tri-junction stones were placed in the charge of *chokidars* and *matbars*, and, when possible, receipts were obtained from them.

286. The total area which required to be surveyed proved to be 244 square miles, and the traversing of this area was completed. The detail survey of 46 villages has been completed, and considerable progress has been made in the two largest of the remaining five. The area thus surveyed on the 16-inch scale amounted to 215 square miles, of which 105·5 was cultivated land, containing 406,133 fields and 105,000 holdings. An area of about 30 square miles still remains unsurveyed in detail. The work was checked by 55·4 miles of *partal* lines by Europeans and by 128·3 miles by natives, giving an average of $1\frac{3}{4}$ miles per square mile of survey. The entries in the village records were also checked by both Europeans and natives to an extent of 16 per cent. of the whole.

287. The field season closed on the 9th June, the sudden setting in of the monsoon stopping all out-of-door work. The writing of the village records was much delayed for want of the proper forms, but the papers of 34 villages were completed and those of 7 more were in hand. The identification of the *Maghi daghs* of 24 villages had also been made when field-work was stopped. An attempt was made to continue the detail survey of the remaining villages during the recess, but it had to be abandoned on account of fever; by the end of September, however, the record-writing of the above-mentioned 7 villages was completed, as well as the identification of the *daghs* of all the villages that had been surveyed.

288. The cost has been much enhanced for the following reasons:—(1) the high wages paid to menials, almost double that which is paid in Tirhoot and Northern Bengal; (2) the defective demarcation and total absence of line-cutting in advance; (3) the very small size of the fields; (4) the delay caused by the non-receipt of the *khasra khatian* forms; (5) the extra work entailed by the identification of the *Maghi daghs*; and (6) the excessive difficulty in getting the *zamindars* and cultivators to attend during the writing of the records.

289. Until July there was but little sickness, but during that month an epidemic of fever broke out, and by the end of it every man had been attacked; though none died, some became so debilitated as to render it advisable to send them home; the fever was of a remittent type, and change of air seemed to be the only permanent remedy for it. An attempt was made to replace those who were obliged to leave, but the new arrivals fared no better, and it was stopped. The recess work during July and August, in consequence of this sickness, fell into arrears, but these were made up again in September and October by extra hours. The daily average of sick during the field season was about 3 per cent., whilst during the recess it exceeded 75 per cent. Under these circumstances it will not be advisable to allow the detachment to recess again at Cox's Bazaar, and as there is no accommodation at Chittagong, it would be better that it should be moved to whatever station is selected for the recess quarters of No. 2 Party, to which this detachment will be attached during next season.

290. To Mr. O'Sullivan much credit is due for the amount of work he succeeded in doing in the face of such adverse circumstances. Mr. Slack, the officiating Collector, rendered him most valuable assistance as did also Mr. Cosserat, the sub-divisional officer at Cox's Bazaar. Unfortunately the Settlement officer did not co-operate with the officer in charge of the party as he might have been expected to do.*

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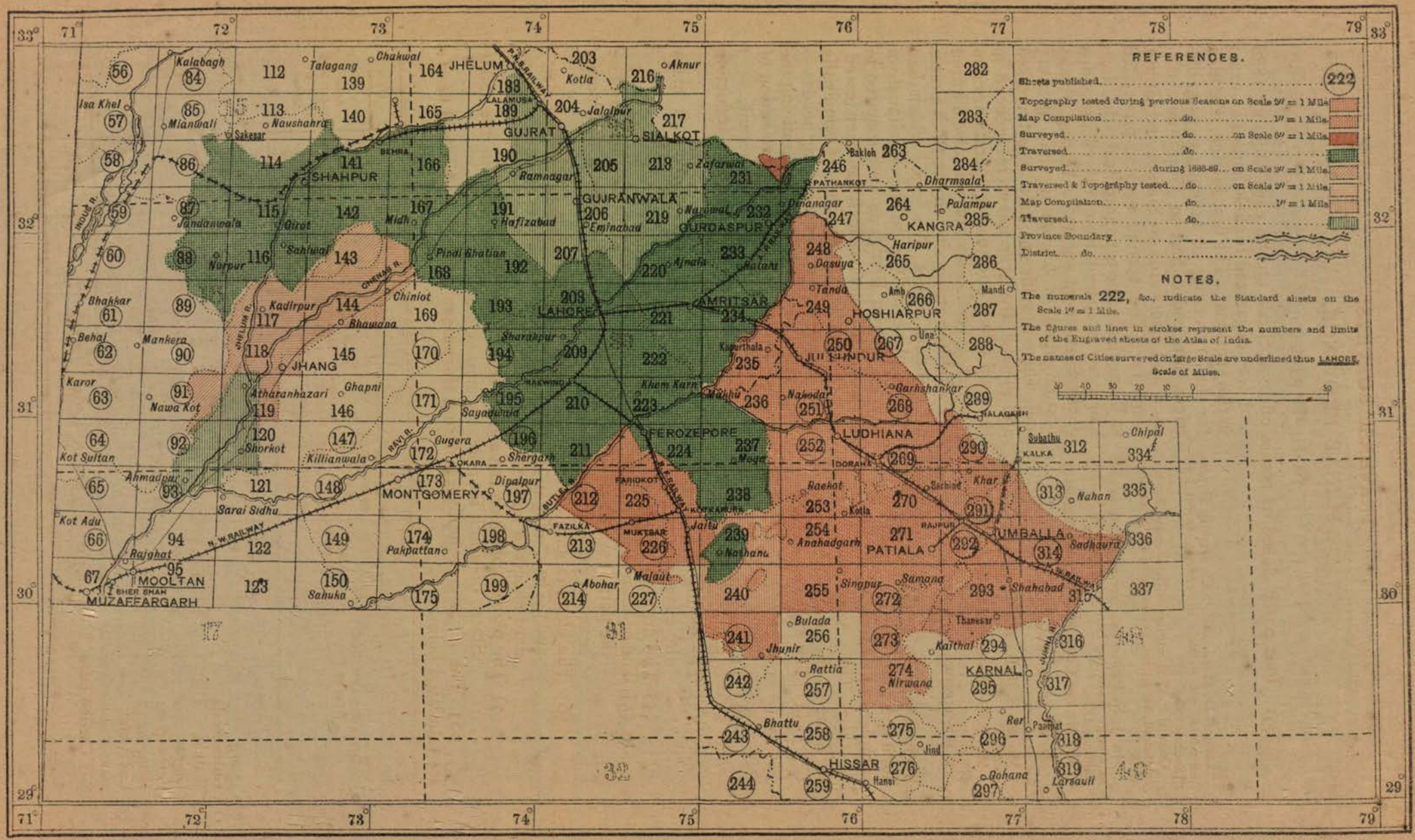
* Mr. O'Sullivan in reporting of Mr. Lee, says that he is most careful in the examination of work both in the field and in recess, and that he considers him an excellent cadastral officer. Mr. Lee suffered much from fever, and was at last forced to take a month's privilege leave. The names of the following natives are brought forward as having done good work: Hilaluddin, Latif-ulla Khan, Angamothoo, Makhan Lall, Barkut Hosein, Binda Lall, and Goburdhon Chatterjee.

PUNJAB SURVEY.

INDEX TO THE SURVEY OPERATIONS IN THE PUNJAB.

No. 1 PARTY.



Reg. No. 668 S. I. D.—4-3-90.—680.

Photo., S. I. O., Calcutta.

TRAVERSE SURVEYS.

PUNJAB PROVINCE.

No. 1 Party.

291. This party closed its recess office at Simla on the 14th October 1888 and was organized for field duties as usual in two sections. The first section, intended for the traversing of revenue-paying districts, proceeded first to Gujranwala district, and afterwards to Sialkot and Gujrat districts. The second section proceeded to Jhang, but as no topographical reductions had been prepared from the village maps of the Settlement survey for testing, it was first engaged in traversing that district; and when a sufficient area was traversed and plotted, the *shujrahs* were reduced in the field office, and testing operations commenced. To this section was also allotted the skeleton traversing in the Sikh States of standard sheet No. 256, which had been compiled in the Calcutta Office, and the plane-tabling on the 2-inch scale of such portions of the "Bar" and "Thal" of district Jhang, as were required to complete up to margins the mapping of the standard sheets which had been tested.

Personnel.

Colonel D. Macdonald, S.C., Deputy Superintendent, 1st grade, in charge from 16th January 1889.
Colonel F. Coddington, S.C., Deputy Superintendent, 1st grade, in charge to 1st November 1888.
Mr. J. S. Pemberton, Surveyor, 1st grade, in charge from 1st November 1888 up to 15th January 1889.
Mr. George Campbell, Assistant Surveyor, 1st grade.
Mr. W. H. D. Ewing, Assistant Surveyor, 1st grade.
Mr. F. S. Bell, Assistant Surveyor, 2nd grade.
Mr. F. P. Walsh, Assistant Surveyor, 3rd grade.
34 sub-surveyors and others.

292. The several operations on which this party was engaged are principally the same as those of last season and may be classed under the following heads:—

(1) The skeleton traversing of villages for the purpose of determining the co-ordinate distances of tri-junction points; and the projection of maps of the tri-junctions on the scale of 2 inches to the mile.
(2) The insertion of topographical details on these maps by reduction from the Settlement survey village maps.
(3) The testing and correcting (where necessary) of the reduced maps by examination in the field.
(4) The drawing of the fair maps on the 2-inch scale.
(5) The re-drawing of the old 1-inch maps of the Sikh States, to complete the portions of these territories falling within the present continuous series of maps of standard size.
(6) The plane-tabling on the 2-inch scale of such portions of the "Bar" and "Thal" of district Jhang as were required to complete the standard sheets in hand up to margin.
(7) The plane-tabling on the 1-inch scale of a small area in the Sikh States of which no previous map existed.

293. The areas accomplished during the season under these several heads are tabulated below—

Districts and Sikh States.	(1) Area traversed.	(2) Area compilation by reduction (2-inch scale).	(3) Area tested (2-inch scale).	(4) Area finally mapped (2-inch scale).	(5) Area compilation and final mapping (1-inch scale).	(6) Area plane-tabled (1-inch scale).	(7) Area plane-tabled (1-inch scale).
	Sq. miles.	Sq. miles.	Sq. miles.	Sq. miles.	Sq. miles.	Sq. miles.	Sq. miles.
Jhang	3,423	2,006	1,564	2,134	...	698	...
Gujranwala	1,220	...	...	...	...	...	...
Sialkot	1,955	...	...	...	...	...	...
Gujrat	200	...	...	...	...	...	...
Ferozepore	...	1,806	...	214	...	...	...
Jullundur	...	...	...	36	...	...	...
Ludhiana	...	...	...	144	...	...	...
Carried over	6,798	3,812	1,564	2,528	...	698	...

Districts and Sikh States.	(1) Area traversed.	(2) Area compilation by reduction (2-inch scale).	(3) Area tested (2-inch scale).	(4) Area finally mapped (2-inch scale).	(5) Area compilation and final mapping (1-inch scale).	(6) Area plane-tabled (2-inch scale).	(7) Area plane-tabled (1-inch scale).
Brought forward .	6,798	3,812	1,564	2,528	...	698	...
Sikh States.							
Kapurthala . .	...	...	...	139	...	...	...
Faridkot . . .	...	...	...	81	...	...	...
Patiala, &c. . .	510	...	...	...	722	...	70
Totals .	7,308	3,812	1,564	2,748	722	698	70

294. The operations under head (1) have been completed in Jhang, Gujranwala and Sialkot, and a small portion of Gujrat has also been traversed. Under head (2) the operations are complete for Ferozepore and Jhang. Under head (3) only a portion of Jhang has been completed. Under head (4), the final mapping of sheets Nos. 118 and 144 has been completed, and the mapping of the following sheets has been done, and carefully examined, as far as materials were available, *viz.*, sheets 90, 116, 117, 119, 142, 143, 145, 168, 169, 211, 212, 224, 234, 235, 236, 237, and 238. These sheets cannot be completed till the districts, portions of which fall within their margins, have been tested. Under head (5), the following sheets have been completed, *viz.*, 227, 228 and 241, and the mapping on the 1-inch scale of the Sikh States has been completed in sheets 238, 239 and 240; but these sheets are still incomplete, as portions of 2-inch work, which still remains for testing, have to be included. Under head (6), the whole area belongs to Jhang; and under head (7), to the Sikh States. Reductions to the scale of the Atlas of India have been drawn for all the 2-inch standard sheets which have been finally mapped to date. The area of 2-inch mapping thus reduced amounts to 2,748 square miles.

295. In accordance with the design of the present operations that the traversing in revenue-paying districts, besides being executed for purposes of map compilation, should also furnish data for testing the accuracy of the Settlement survey village maps, which are being constructed on a basis entirely distinct from the traversing, statements of co-ordinate distances of all village tri-junctions (which are the common points of the two surveys) and of the computed direct distances between tri-junctions, are being prepared for each of the districts. These have been furnished during the present season for districts Lahore (1,647 villages, area 3,513 square miles), Amritsar (1,105 villages, area 1,573 square miles), Gujranwala (1,202 villages, area 2,580 square miles), Sialkot (2,217 villages, area 1,955 square miles), and Jhang (818 villages, area 2,423 square miles): grand total, 5 districts with 6,989 villages, covering an aggregate area of 12,044 square miles.

296. The recess office of this party was inspected by Colonel J. Sconce, Officiating Surveyor-General, on the 12th July 1889.

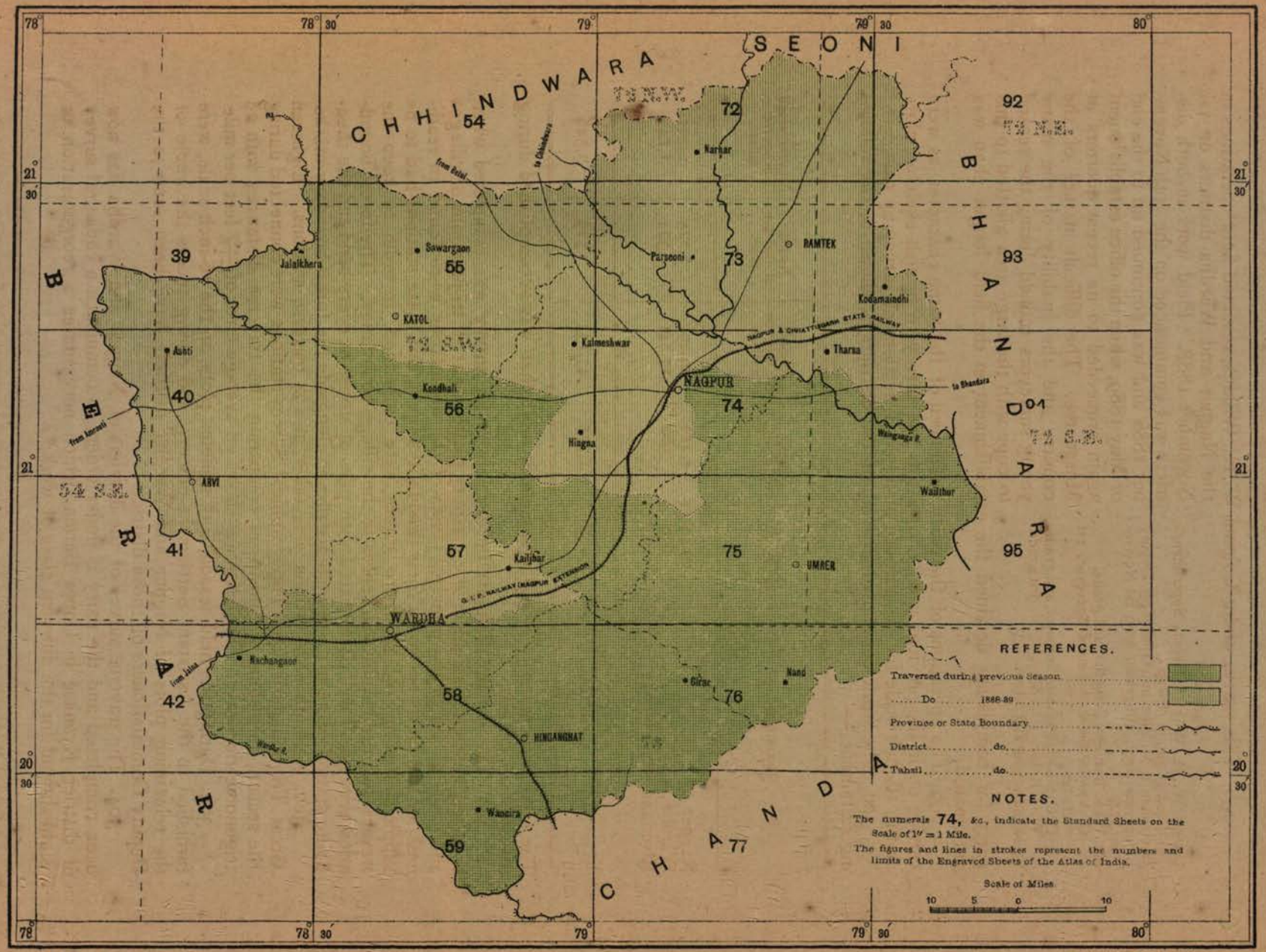
297. During the next season, 1889-90, the party will be reduced in strength and will be employed on the traverse survey of Gujrat and on the test survey of the 2-inch mapping in Ferozepore which has been compiled from the Settlement which comprise about three standard sheets. These field operations, it is expected, will be completed by the end of the current financial year, but a small establishment will be required during the recess season to do the fair mapping and work out the traverse computations. After this the party will be withdrawn from the Punjab in accordance with orders conveyed in Revenue and Agricultural Department letter No. $\frac{519}{88\text{-}22}$, dated 11th October 1889.*

* Colonel Macdonald reports very favourably of Mr. Pemberton who held temporary charge of the party from 1st November 1888 to 16th January 1889 and managed all the duties connected with it satisfactorily, and also of Messrs. G. Campbell, W. H. D. Ewing and F. S. Bell. From amongst the natives, who all worked well, the names of Elahi Bux. Ramjas, Awaz Ali, Elahi Bux II, Moula Bux, Mahomed Akbar, Abdul Wahid, Gurmakh Singh and Ishar Singh are selected for special mention.

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTS. NAGPUR & WARDHA.

No. 3 PARTY.



Reg. No 937, S. I. D.—3-3-90—580.

Photo-litho., S.I.O., Calcutta.

NAGPUR AND WARDHA DISTRICTS, CENTRAL PROVINCES.

No. 3 Party.

298. This party, under Colonel W. H. Wilkins, resumed field operations in the Nagpur and Wardha districts on 1st November 1888. Field work in both districts was commenced on the 10th November 1888 and was continued up to the end of May 1889, when the office establishment again proceeded to its recess quarters at Mussooree. The difficult nature of the country and the inability of the many young surveyors trained during the season to cope with the large area allotted to this party for completion detained the establishment in the field longer than was anticipated.

Personnel

Colonel W. H. Wilkins, Deputy Superintendent, 2nd grade, in charge.
Lieutenant J. M. Fleming, Officiating Deputy Superintendent, 4th grade, from 1st November 1888.
Mr. W. S. Buttress, Surveyor, 2nd grade.
„ G. Vander Beek, Assistant Surveyor, 1st grade.
„ O. D. Smart, Assistant Surveyor, 2nd grade.
„ W. J. Baker, ditto, 3rd grade.
63 sub-surveyors and others.

299. The operations of the party have been of the same character as were carried on in the previous year, *i. e.*, a traverse survey to furnish skeleton plots on the 16-inch scale for the purpose of a village settlement survey by *patwáris*.

300. The work completed in each of the districts is shown in the following statement:—

Districts.	Number of villages.	Number of sub-traverses.	Number of traverse stations.	Number of skeleton plots.	Area traversed in square miles.
Nagpur	1,149	1,213	29,292	2,225	2,201
Wardha	659	562	17,841	1,304	1,147
River and forest blocks .	194	...	...	...	...
Total .	2,002	1,775	47,133	3,529	3,348

The total area traversed is 438 square miles more than was accomplished during the previous season.

301. The demarcation of the districts under survey was completed when the party entered the field. The masonry platforms at all tri-junctions of villages and stone pillars at the principal bends of the boundaries were found in readiness for the surveyors to fix their theodolites upon, but these stations had to be supplemented by others where stones were embedded, in order to keep the traverses to the requisite closeness to the village boundaries. The forest boundaries were found well demarcated with piles of stones at every bend and the theodolite stations were in every instance placed alongside the forest boundary marks.

302. Azimuth observations were taken at 194 traverse stations. Eighteen Great Trigonometrical and Topographical Survey stations were connected during the season, furnishing the means of comparing the traverse distances with 28 trigonometrical rays. The chaining shows an average error of $\frac{+2\cdot85}{-2\cdot81}$ feet per mile.

303. During the field season, 433 skeleton plots, on the 16-inch scale, were furnished to the Assistant Settlement officers, and during recess the whole of the remaining plots of Nagpur and Wardha districts have been sent to the Deputy Commissioners of those districts.

304. The traverse survey of the districts of Nagpur and Wardha has now been completed and the party is under orders to commence a cadastral survey of district Kyauksé in Upper Burma, which necessitates a reorganisation of establishment for the different class of work.*

* Colonel Wilkins in reporting of his officers states that Lieutenant J. M. Fleming has given entire satisfaction in all the work entrusted to him, and that Messrs. Vander Beek and O. D. Smart have done very good work; he also favourably mentions Mr. W. J. Baker. Of the native establishment he highly commends Sub-Surveyors Bhagobutty Charn Chuckerbutty and Kedar Nath, and adds that Allahdad Khan, Dharonidhar Mukerji and Surfraz Khan deserve credit.

CHANDA AND BHANDARA DISTRICTS, CENTRAL PROVINCES.

No. 9 Party.

305. This party, which had completed during the previous season the traverse survey of the Jubbulpore and Seoni districts, was transferred to districts Chanda and Bhandara. The party left its recess quarters, Jubbulpore, on 1st November for field operations, and remained in the field until 1st May 1889, when it returned for recess to Kampti.

Personnel.

Mr. G. H. Cooke, Deputy Superintendent, 3rd grade, in charge.
„ H. E. T. Keelan, Surveyor, 1st grade, from 13th May to 22nd October.
„ J. Todd, Surveyor, 2nd grade, up to 13th May 1889.
„ H. Dowman, Surveyor, 3rd grade.
„ A. George, Assistant Surveyor, 1st grade.
„ A. Ewing „ „ 2nd „
35 sub-surveyors and others.

306. The nature of the operations has been similar to those of the previous season and such as are being carried out in other districts of the Central Provinces, the object being to furnish skeleton plots of the traversed points as a frame-work to the field-by-field survey to be undertaken by *patwáris* under the Settlement Department.

307. The village boundaries, as a rule, were found to be well demarcated by stones or mud pillars. The forest boundaries in the Chanda district were also well defined and marked with cairns of stones piled round stakes of wood embedded in the ground; but those in the Bhandara district, in some cases, were found incomplete owing to recent changes and additions to the forest tracts. It has been decided that all the forest reserves in the Bhandara district are to be surveyed on the scale of 4 inches to 1 mile by the Forest Survey Department, and the traverses appertaining to the forest blocks have accordingly been computed and made over to the Forest Department, who were to commence operations in November 1889. The survey stations were all marked by stone prisms, 2 feet in length by 6 inches square, embedded in the ground, except in those cases where the demarcation stones on the village boundaries were found suitable and such were made use of; 48,669 of these stone prisms were embedded during the season at a cost of ₹1-8-6 per square mile.

308. Tracings of the village boundaries were taken from the old 4-inch Revenue survey maps on which all the new traverse stations were plotted; these traces were made over to the respective *malguzars*, who have given a receipt for the number of stones embedded within their boundaries and are responsible for their preservation.

309. The work which has been accomplished in each of the districts of Chanda and Bhandara is tabulated in the following statement:—

District.	Number of villages.	Number of sub-traverses.	Number of traverse stations.	Number of permanent marks.	Area in square miles.	Remarks.
Bhandara . .	844*	1,100	26,375	20,566	1,763	* Besides these there are 70 forest blocks.
Chanda . .	977†	1,666	33,440	28,103	2,709	† Besides these there are 16 forest blocks.
Total .	1,821	2,766	59,815	48,669	4,472	

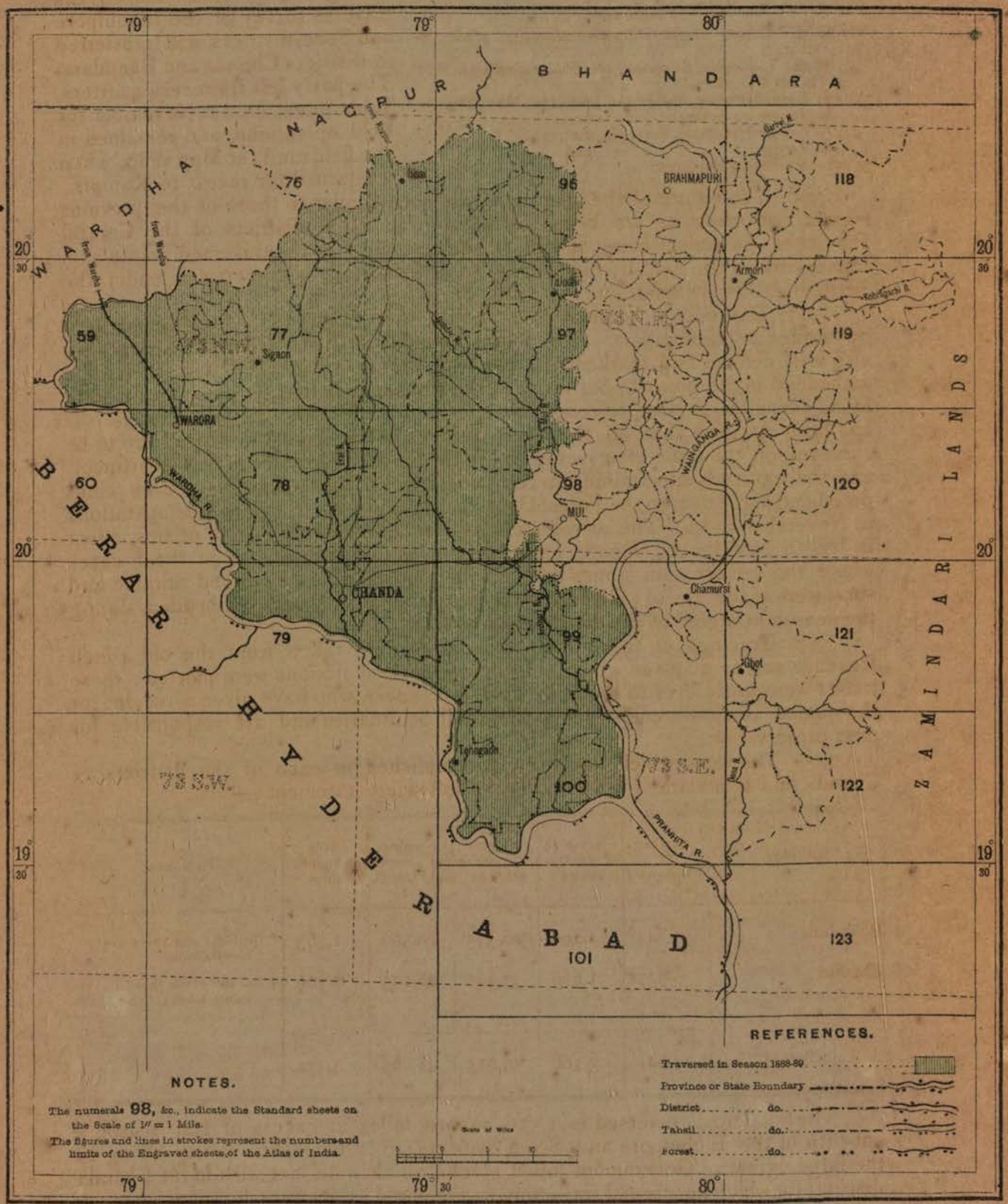
The total area traversed is 1,556 square miles in excess of last season's out-turn in the Jubbulpore and Seoni districts; this increase is partly owing to the large extent of Government forest blocks which were met with in the Chanda district, for which no internal traversing was required; they were, however, so much scattered in detached blocks that the labour of connecting them was very great, and tended considerably to counterbalance the saving of labour in not having to do any internal traversing.

310. The angular work was checked by observations for azimuth taken at 474 stations, which gives an average of one azimuth station to every 9 square miles. Connections have been made with 13 stations of the Great Trigonometrical

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTRICT CHANDA.

No. 9 PARTY.



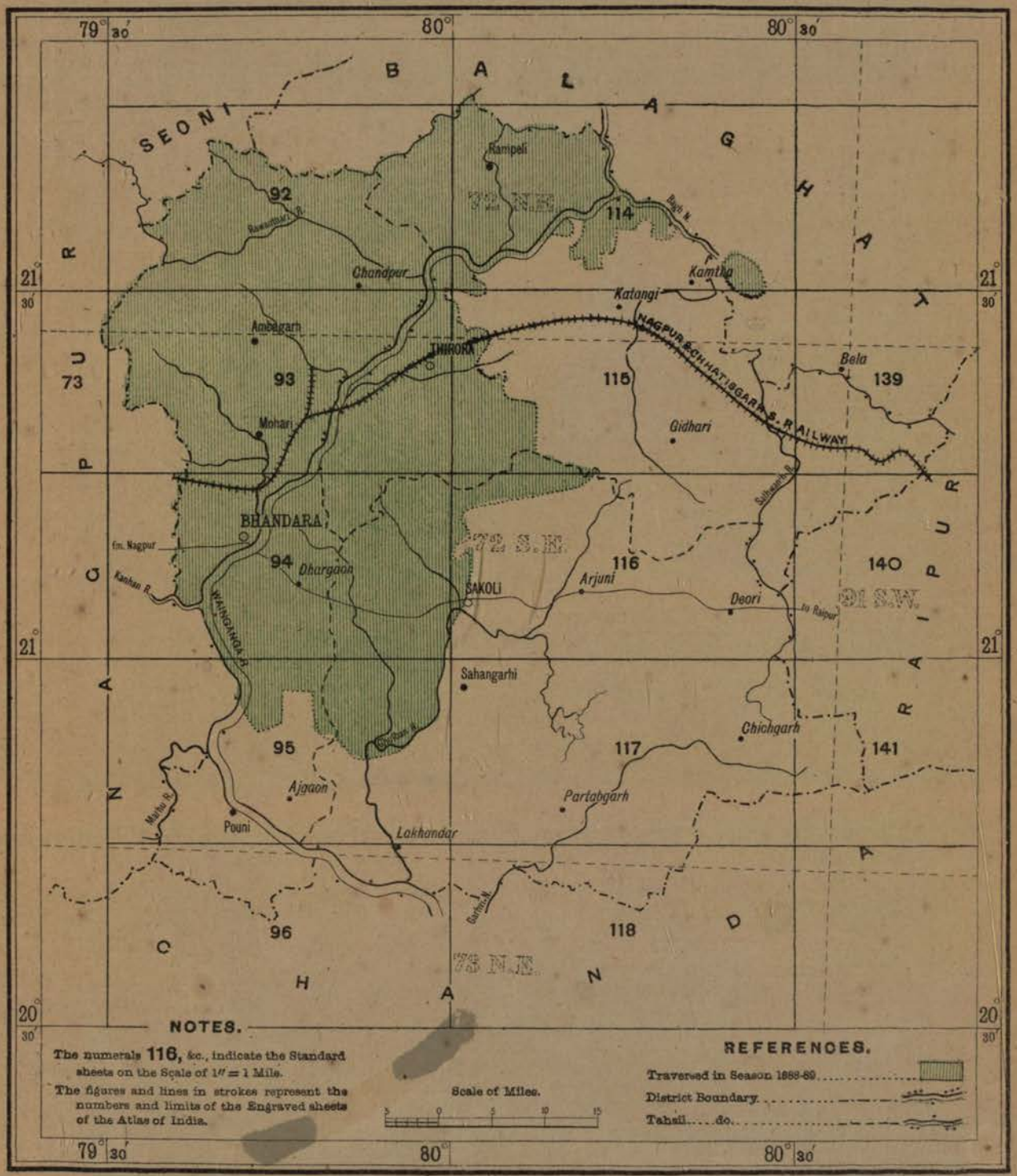
Reg. No. 639, S. T. D.—4-3-90.—580.

Photo., S. I. O., Calcutta.

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTRICT BHANDARA.

No. 9 PARTY.



NOTES.

The numerals **116**, &c., indicate the Standard sheets on the Scale of 1″ = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Atlas of India.

Scale of Miles.

5 0 5 10 15

REFERENCES.

Traversed in Season 1888-89.....

District Boundary.....

Tahsil.....do.....

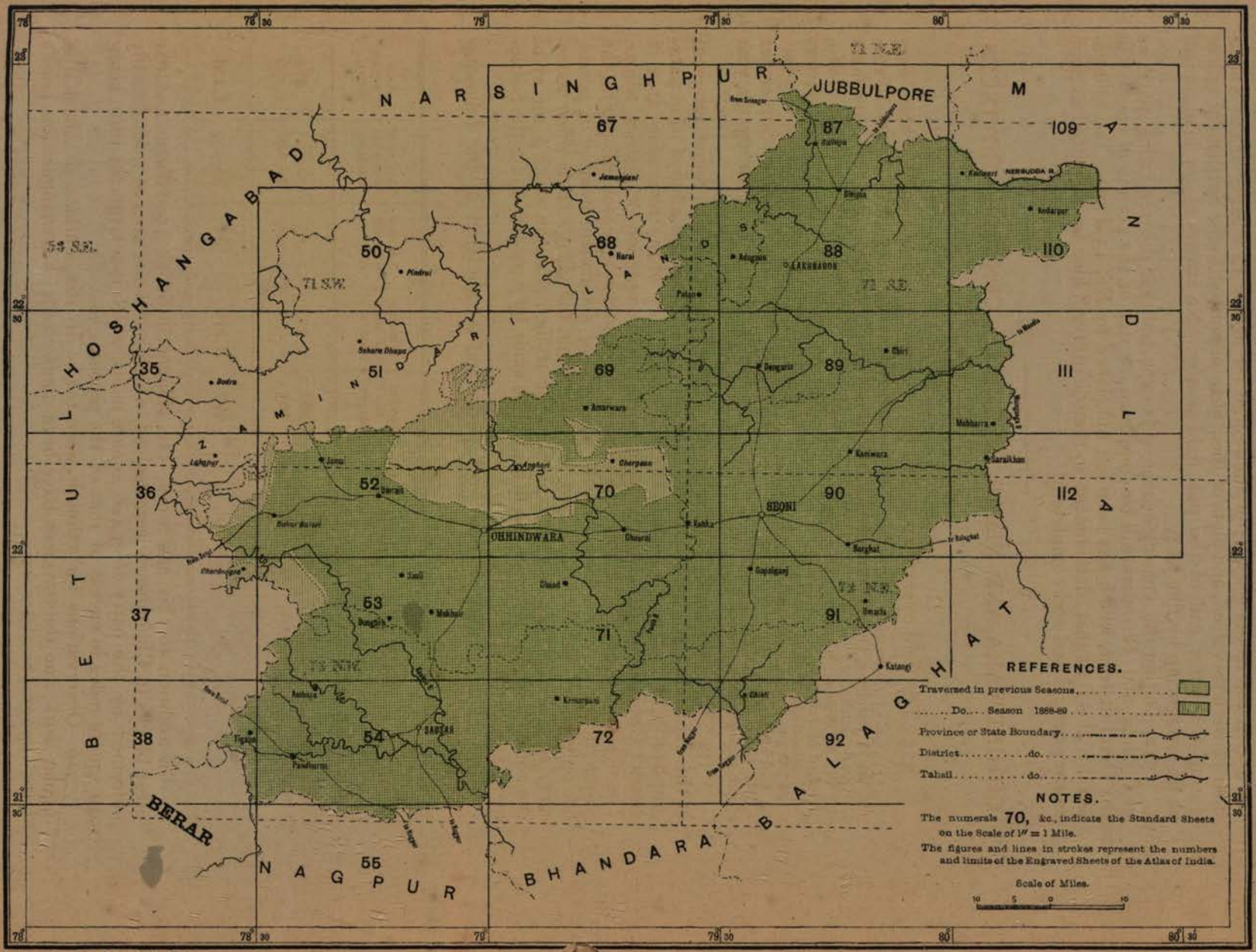
Reg. No. 938, S. I. D.—4-3-90.—530.

Photo., S. I. O., Calcutta.

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTS. SEONI AND CHHINDWARA.

Nos. 9 & 11 PARTIES.



Reg. No. 938. S. I. D.—6-3-90.—500.

Photo-litho., S. I. O., Calcutta.

Survey, by which comparisons have been made in 18 cases between the distances as derived from the traverse and those derived from the triangulation; these show an average error of 4·87 feet per mile.

311. The skeleton plots of the whole season's out-turn of 1,821 villages, contained on 3,618 sheets, were supplied to the Settlement Department before the end of the recess season; in addition to the above, 14 villages of the Raipur district were traversed, and plots of them were submitted to the Settlement officer during the latter end of the past field season. No arrears of any kind remain to be brought up by this party.

312. During the ensuing season it is expected that the remaining portions of Chanda and Bhandara will be completed, as well as the portion of country in the Betul district, which has been left unfinished by No. 13 Party: the villages left by the Balaghat detachment in that district will also be submitted as soon as they are revised and completed.*

CHHINDWARA AND NIMAR DISTRICTS, CENTRAL PROVINCES.

No. 11 Party.

313. The field operations of this party were commenced in the Chhindwara and Nimar districts of the Central Provinces during the first week of November 1888 and closed early in June 1889, when the party returned to recess quarters in Poona. Mr. W. H. Patterson, who was transferred to this party in September 1888, held charge of it during the year under report.

Personnel.

Mr. W. H. Patterson, Deputy Superintendent, 4th grade, in charge.
„ W. A. Wilson, Surveyor, 2nd grade, up to 23rd March 1889.
„ J. Newland, Surveyor, 4th grade.
„ P. White, Assistant Surveyor, 1st grade.
„ C. George, ditto, 2nd „
„ H. Charrier, ditto, 3rd „
46 sub-surveyors and others.

314. The programme for the season was as follows:— The re-measurement of the inaccurate polygons in districts Seoni and Chhindwara alluded to in paragraph 269 of last year's report, the traverse survey of the remaining area in district Chhindwara, and the commencement and completion of district Nimar. The object of the operations was the same as in the previous season, *viz.*, to fix the tri-junction pillars of villages and the positions of a sufficient number of points, not only on or near the boundaries, but also within the village lands when necessary, so as to provide skeleton plots on the 16-inch scale on which a survey of the actual boundaries and of the fields will be made by *patwáris* under the Settlement Department.

315. The out-turn of new work performed is tabulated in the following statement:—

Districts.	Number of villages.	Number of sub-traverses.	Number of forest blocks.	Number of traverse stations.	Area in square miles.
Chhindwara	262	325	35	6,693	484
Nimar	705	951	26	22,216	1,736
Total	967	1,276	61	28,909	2,220

In addition to this new work, 114 villages in Seoni, 359 villages and 101 forest blocks in Chhindwara were revised, which raises the area of work actually performed by the party to 3,446 square miles, which is a large out-turn, being 942 square miles in excess of that of the previous year.

316. Observations for azimuth were taken at 162 stations to check the angular work, and the traverses have been connected with 6 triangulation points of the topographical survey.

* Mr. Cooke reports favourably of Messrs. J. Todd, H. Dowman, A. George, and A. Ewing; and specially mentions Mr. Dowman, who held charge of the camp working in the Chanda district. From amongst the native establishment he selects Lall Mohun Gungopadhya, Tara Prosunno Roy, Kesho Vaijnath, and Manohar Daji as worthy of special mention; and reports well of S. R. McGowan, Upendra Nath Mukerjee, Behari Lall, Irfan Ali, Murli Manohar, Gunpat Rai, Peari Lall, and Gopal Sitaram.

317. All the tri-junction marks of the village boundaries and as many of the intermediate boundary marks as were found suitable were utilized for traverse stations, and all other traverse stations have been permanently marked by dressed and undressed stones, embedded in the ground. In Chhindwara the stones were supplied by the *malguzars*, but in Nimar a large proportion of stones, quarried and dressed in the district at the Government expense, were used; they were supplemented by undressed stones supplied by the *malguzars*. The stones furnished by Government were mostly used in the villages in the plains where the villagers were unable to procure them for themselves; the transport of them was paid for partly by Government and partly by the *malguzars;* the latter paid entirely for the embedding of them.

318. In order to expedite as much as possible the preparation of the skeleton plots of those villages traversed in the previous season which had to be revised, a special plotting establishment was attached to the Chhindwara section, and as fast as the re-measurements were received the plots were prepared and the sheets were furnished to the Deputy Commissioner. By June all the plots of both Seoni and Chhindwara, together with the areas, were finally made over to the district officials.

319. During the recess months the skeleton plots of sheets in Nimar with areas were despatched periodically, and it is anticipated that the complete number will be submitted early in November. Thus the traverse surveys in the three districts of Seoni, Chhindwara and Nimar have been completed, and the party as now constituted will be re-organized and transferred to Upper Burma, where it will be employed on geographical surveys.

The recess office was inspected by the Surveyor-General at Poona in July. The backward state of the office computations referred to in paragraph 171 of the previous report had been satisfactorily dealt with, and the records of the current season were found to be in a good state of progress and being prosecuted systematically. Credit is due to Mr. Patterson for bringing the work of the party, which he found in some confusion, into good order, and in completing the whole of the records satisfactorily, which, owing to the large area dealt with, was a laborious task.*

SAUGOR AND BALAGHAT DISTRICTS, CENTRAL PROVINCES.

No. 12 Party.

320. The field establishment of this party assembled at the end of October 1888 at Saugor, where the recess office had been held, and took the field on the 1st November. It was divided into two sections: the one under Mr. Jackson worked in the Saugor district, which was completed, except some of the computations and the revisions of certain traverses; this section stopped field-work on the 15th May and proceeded to Naini Tal, where the party went into recess quarters. The other section carried on the traversing in the Balaghat district and was formed into a separate detachment; the report of its operations will be found further on.

Personnel.

Mr. E. J. Jackson, Officiating Deputy Superintendent, 3rd grade, in charge.
„ J. T. U. Coxen, Surveyor, 4th grade. up to 11th November 1888.
„ E. F. Berkeley, Assistant Surveyor, 2nd grade, from 1st September 1889.
„ P. J. Serrao, Assistant Surveyor, 2nd grade, from 1st March 1889.
„ H. A. Charrier, Assistant Surveyor, 2nd grade, up to 1st February 1889.
38 sub-surveyors and others.

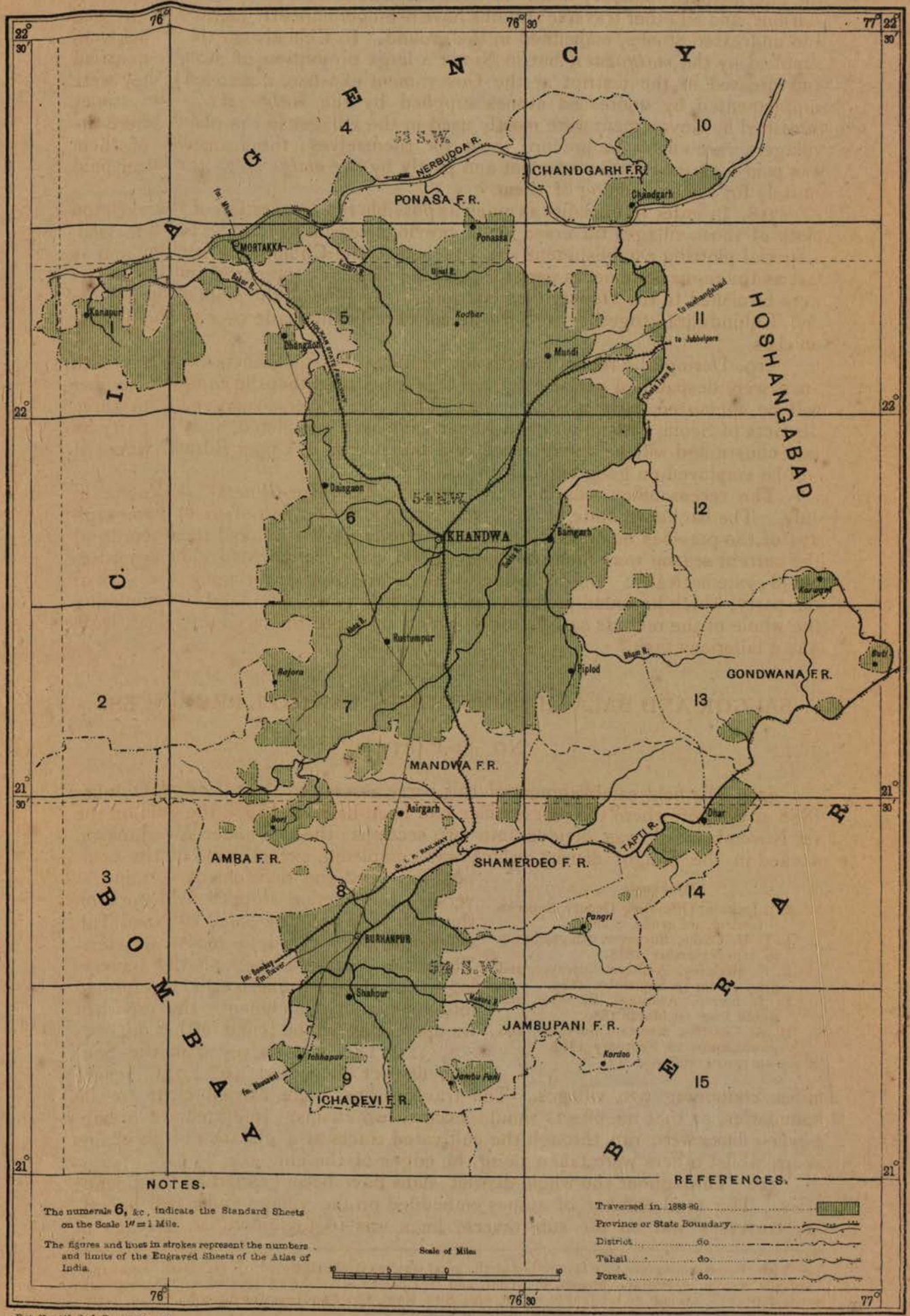
321. The area surveyed in the Saugor district amounted to 1,771 square miles, containing 930 villages. The traverse lines were carried close to the boundaries, so that no offsets should exceed two chains. Intermediate or subtraverse lines were run through the cultivated tracts at a distance of 30 chains apart, whilst others were taken along the edges of the jungle.

322. Throughout the whole district slabs have been erected on the boundaries. The total number of stones embedded on the village and forest boundary traverses and on the sub-traverse lines was 16,395, giving an average of

* Mr. Patterson reports very favourably of the good services rendered by Mr J. Newland, who supervised the section in Nimar. Messrs. P. White and H. Charrier are also well reported on. Amongst the native staff the following are brought to notice, *viz.*, Sita Ram, Ori Panchey, Inayutoollah Khan, Nathu Khan, Matapalal, Krishnaji Mahadeo, and Balwant Vishnu.

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTRICT NIMAR. No. 11 PARTY.



NOTES.

The numerals 6, &c, indicate the Standard Sheets on the Scale 1″ = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved Sheets of the Atlas of India.

Scale of Miles

REFERENCES.

Traversed in 1888-89

Province or State Boundary

District ..... do.

Tahsil ..... do.

Forest ..... do.

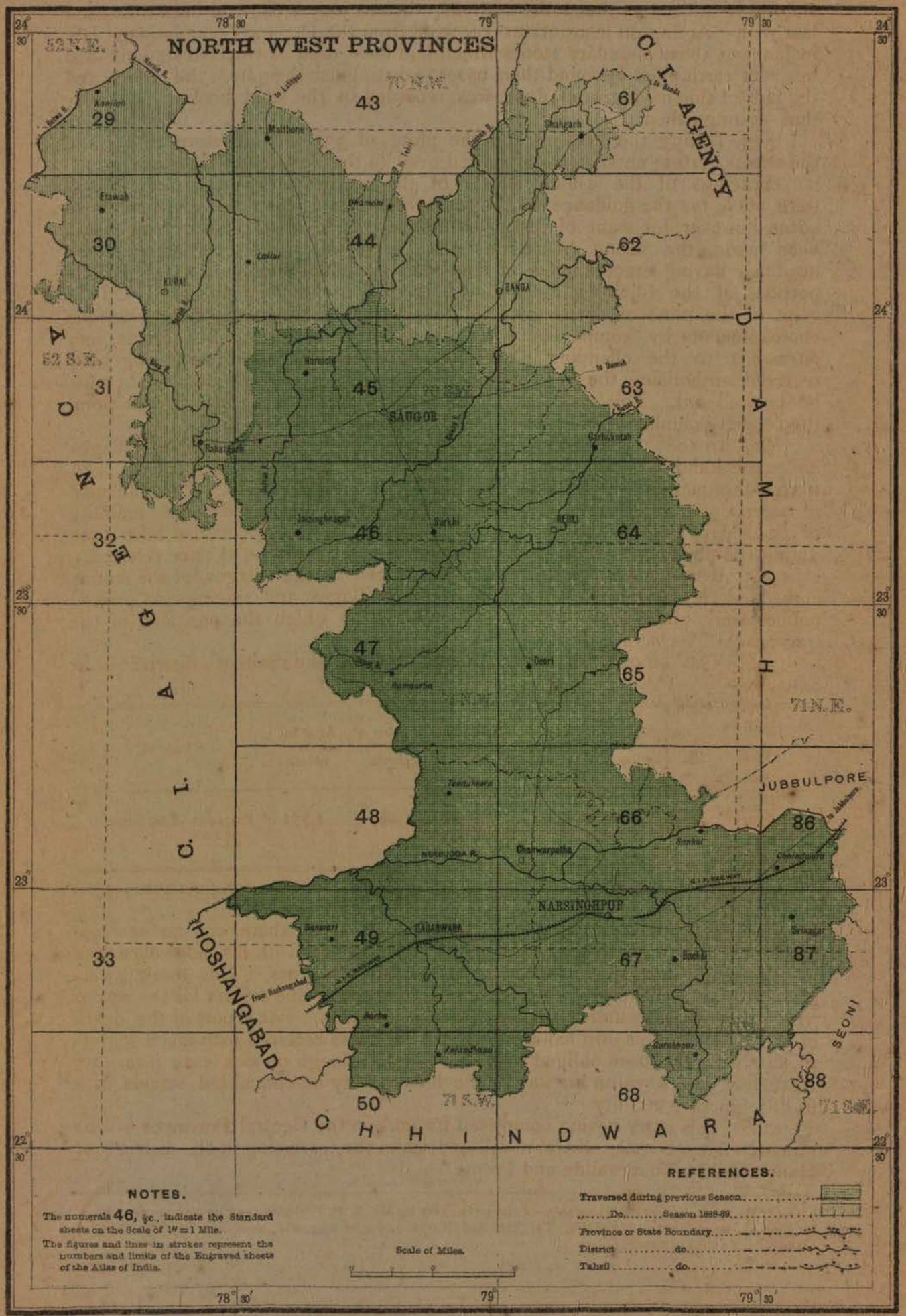
Reg. No. 206. S. I. D.—7-3-90.—500

Photo-litho., S. I. O., Calcutta.

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTS. SAUGOR AND NARSINGHPUR.

No. 12 PARTY.


NORTH WEST PROVINCES
C. I. AGENCY
52 N.E.
70 N.W.
43
61
29
30
44
62
52 S.E.
31
45
63
SAUGOR
32
46
64
47
65
71 N.E.
48
66
86
JUBBULPORE
NARSINGHPUR
49
67
87
33
HOSHANGABAD
50
71 S.W.
68
88
71 S.E.
CHHINDWARA
SEONI
DAMOH
CANDEISH
Etawah
KUIRAI
BANDA
Sagar
Damoh
Rahatgarh
Jhansi
Sirsi
Deori
Narsinghpur
Chhindwara
Seoni
Betul
Multai
Harda
Hoshangabad
Sohagpur
Jubbulpore
Sleemanabad
Kamptee
Nerbudda R.
G. I. P. Railway
Tawa R.
Ken R.
Betwa R.
Jumna R.
Sonar R.
Bina R.
Dhasan R.
Barna R.
Kanhan R.
Pench R.
Wardha R.
Wainganga R.
Pranhita R.
Godavery R.
Indravati R.
Mahanadi R.
Sabarmati R.
Mahi R.
Narbada R.
Tapti R.
Purna R.
Taptee R.
Girna R.
Godavery R.
Manjra R.
Penganga

9·3 stones per square mile as against 13·5 per square mile last season. The smaller proportion is accounted for by the fact that 3,089 of the demarcation slabs were utilised as theodolite stations, whereas only 1,877 had been thus used last year. Acting on instructions received from the Deputy Commissioner late in January, those boundary stones which had been used as traverse stations had heaps of earth piled up round their bases to distinguish them from the others, and the fact of this having been done was recorded in the field books; 950 were thus distinguished.

323. During the field season the plots of 332 villages were made, and the sheets, 516 in number, were handed over to the Settlement Department.

Tracings of the 4-inch sheets of the surveys of 1855-57 and 1863-64 were made for the guidance of the surveyors. In a considerable number of cases however, for want of proper information as to whether any changes had been made, the wrong boundaries were surveyed in the first instance, the headmen having erected piles of stones as boundary-marks so as to include portions of the adjoining forest lands, to which they had no right. On receipt of the plots of these traverse lines, Mr. Jackson, having discovered the encroachments by comparison with the tracings of the old boundaries, sent *parwanas* to the offending parties to the effect that no orders having been received authorising the new boundaries, the old settlement boundaries must be pointed out. This was then done, but time was lost, as new surveys along the correct boundaries had subsequently to be made.

324. In 1888, certain blocks of waste land had been declared to be villages under the Land Revenue Act, and of these no tracings could be obtained; they were consequently surveyed as demarcated by the *patwáris*. The difficulty of ascertaining where these new boundaries ran was enhanced by the inability of the Deputy Commissioner to lend the services of a *kanungo*, as had been done during the previous seasons, to whom doubtful cases could be at once referred.

325. Receipts were taken from the headmen of the villages for the stones embedded on or within the boundaries of their villages, and tracings on printed notices were made from the old 4-inch maps on which the positions of the traverse stations were marked.

326. The amount of work accomplished in the Saugor district is as follows:—

District.	Number of villages.	Number of sub-traverses.	Number of traverse stations.	Number of traverse sheets.	Area in square miles.	Remarks.
Saugor	926*	894	25,146	1,494	1,771	* Exclusive of 69 forest blocks.

A small detachment has been left to complete the computations, plots and revision surveys.

327. In consequence of the sickness of Mr. Coxen, there was no surveyor to assist Mr. Jackson in the numerous duties connected with his field office and in the supervision and inspection of the sub-surveyors. This threw a very great deal of extra work on Mr. Jackson, and credit is due to him for the way in which he has successfully completed so large an area. The report of the death of Mr. Coxen by his own hand on the 8th May was received with much regret; this assistant had been obliged to take a year's furlough on sick leave from 12th November, and when on his way to the hills in May he committed suicide in a fit of temporary insanity.

328. This party having completed its work in the Central Provinces will be transferred to Burma, where it will undertake the traversing in the districts of Hanthawaddy, Tharawaddy and Prome.*

* Mr. Jackson reports favourably of the work done by Mr. E. F. Berkeley, and he also speaks well of Balkishan, Ram Narain Majidulla, Tej Ram and Kania Lal; he specially mentions Rhedoy Chunder Dass for his able assistance.

BALAGHAT DISTRICT.

329 The detachment formed from No. 12 Party, for the purpose of commencing the traverse survey of this district, was placed under the immediate charge of Mr. Little, but it was attached, for convenience of supervision, to No. 9 Party on account of the proximity of that district to Bhandara, and Mr. Cooke, Deputy Superintendent, was ordered to superintend the professional work of the detachment. The section took the field on the 15th November 1888 and went into recess quarters at Kamptee about the end of June 1889. Work was commenced in the south-west corner of the district, and after several changes of programme, which retarded the work not a little, it was decided by the Settlement Commissioner that the traversing should be confined to the villages that came under the last preceding settlement, and to such Government forests as fell within these villages. The operations were entirely within the Balaghat district, but the portions surveyed were much scattered. The area completed was approximately 1,300 square miles, which involved the chaining of 4,361 linear miles. Much of this was over very difficult ground indeed, for on one side was a high range of thickly wooded hills, whilst on the other was the great Sonawani forest, and the precipitous banks of the Weingunga in the centre added to the difficulties.

Personnel.

Balaghat Section.

Mr E. G. Little, Surveyor, 3rd grade, in charge.
„ G. T. Hall, Assistant Surveyor, 1st grade, from 1st November 1888.
25 sub-surveyors and others.

330. All the boundary pillars which were suitably placed were utilised as traverse stations. They are good substantial marks, and having stood since the preceding settlement, were well embedded. Mark-stones for all other theodolite stations not having been prepared beforehand, an arrangement was first made with some contractors in Jubbulpore for the supply of suitable stones properly shaped and dressed. The stones supplied were not up to the required standard, and so instructions were given to use undressed stones not less than two feet in length. In rocky situations where it was not possible to erect such stones, station-marks were cut on the rock *in situ*. The boundaries of two first class Government forests, Sonawani and Pandratola, were demarcated by *paka* pillars, and others with stout posts embedded in stone cairns. All these were fixed by offsets from the traverse lines, but the forest blocks have not been plotted on to 16-inch sheets. The total number of theodolite stations fixed and marked either by stones, trijunction platforms, or by marks *in situ*, was 28,214.

331. Every sub-surveyor was supplied with a tested chain with which he had orders to compare the chain in daily use; these test chains were themselves verified every week with the standard laid down in camp and by the chains of the inspecting officers.

332. Tracings from the old 4-inch maps, on which the positions of all theodolite stations were plotted, have been prepared and given to the headmen of villages for the custody of the marks, and their receipts have been taken and lodged in the district office. Owing to there being no 4-inch maps of the villages in the Baihiar *tahsil*, skeleton sheets were plotted by angles and distances and were given to the headmen.

333. The party suffered from a severe type of remittent fever, more especially on the top of and along the base of the *ghâts*; an irritable form of eczema also prevailed, incapacitating many of the men. There were only two deaths, but many sub-surveyors and measurers were completely broken down in health when they left the district. During the six months the party was at work, there were no less than 26 natives killed by man-eating tigers and it was with difficulty that a general stampede from the parts of the forest inhabited by these animals was prevented.

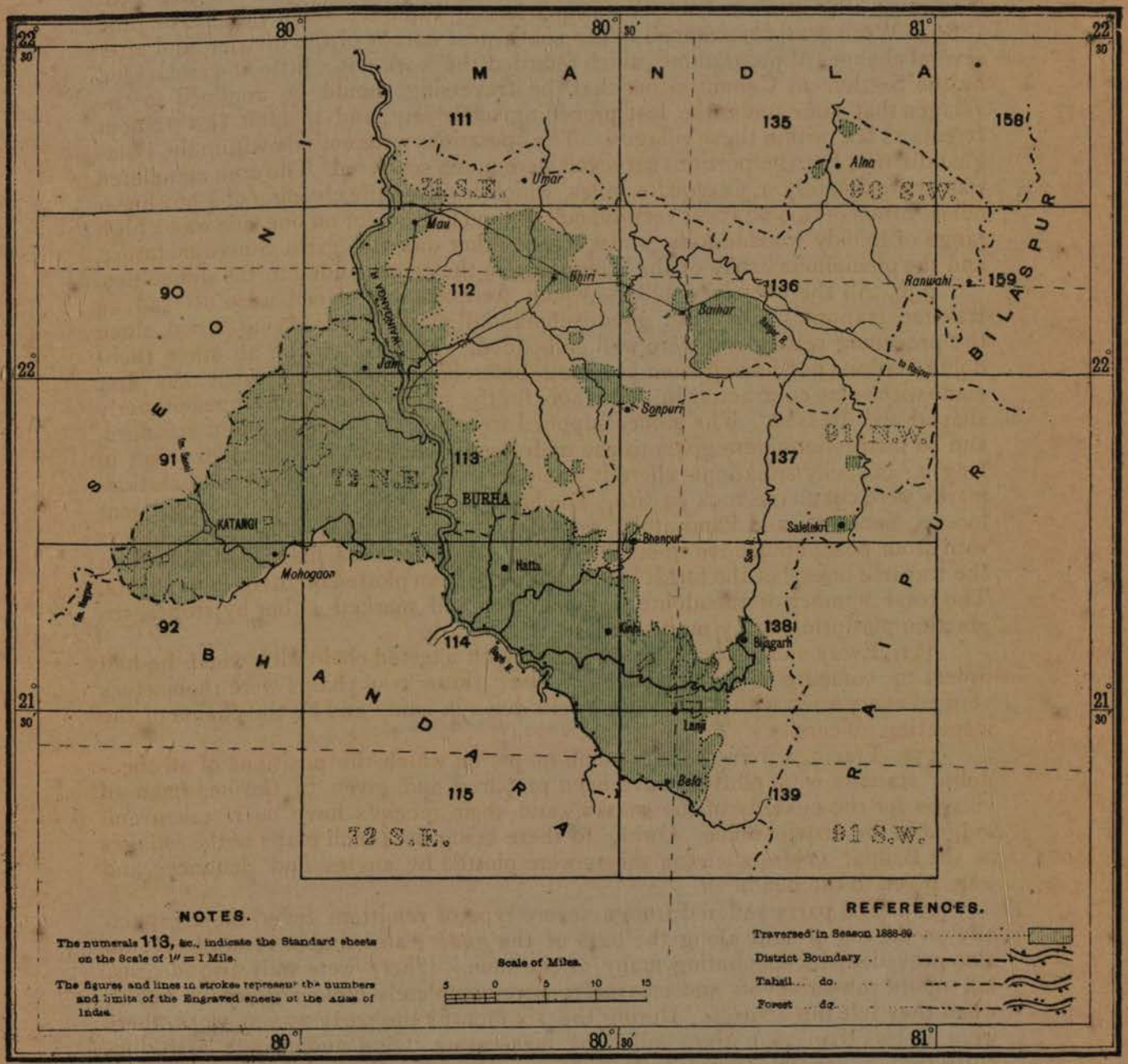
334. The following table gives the total amount of work completed :—

District.	Number of villages.	Number of sub-traverses.	Number of traverse stations.	Area in square miles.	Remarks.
Balaghat . .	699(*a*)	970	28,214	1,300(*b*)	(*a*) Exclusive of 19 forest blocks and 11 river circuits. (*b*) Approximate, as all the village areas have not been finally computed.

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DIST. BALAGHAT.

Balaghat Detachment.



NOTES.

The numerals **113**, &c., indicate the Standard sheets on the Scale of 1″ = 1 Mile.

The figures and lines in stroke represent the numbers and limits of the Engraved sheets of the Atlas of India.

Scale of Miles.

5 0 5 10 15

REFERENCES.

Traversed in Season 1888-89

District Boundary

Tahsil ... do.

Forest ... do.

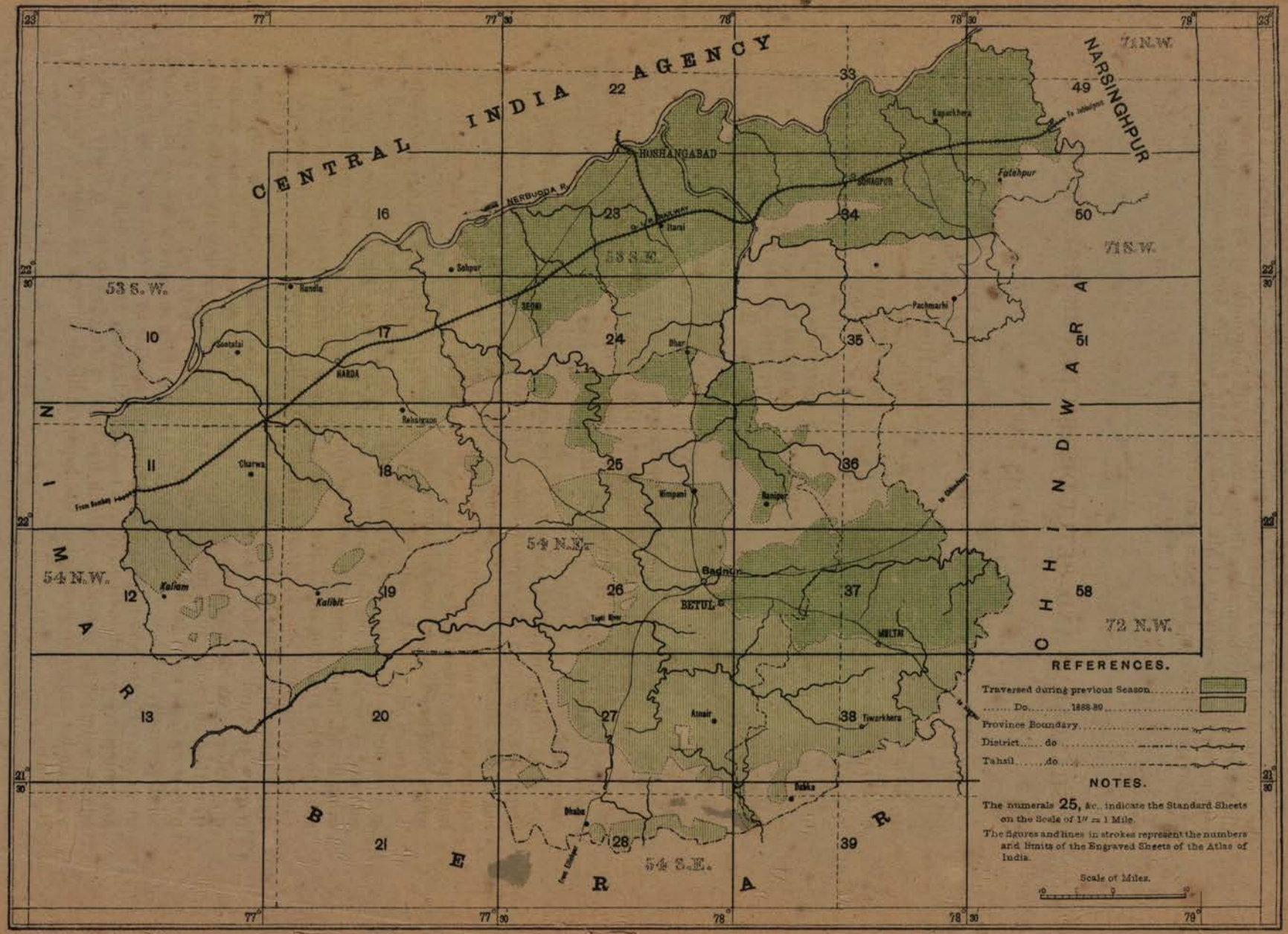
Reg. No. 1000, S. I. D.—17-3-90.—580.

Photo., S. I. O., Calcutta.

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTS. HOSHANGABAD & BETUL

No. 13 PARTY.



Ref. No. 538, S. I. D.—3-3-90.—580.

Photo-litho., S. I. O., Calcutta.

335. To the valuable aid afforded by Mr. Drysdale, the Deputy Commissioner of Balaghat, the successful termination of the work in the wild portions of the *zamindari* lands is greatly due.

336. Out of the 714 villages traversed, which aggregate 1,300 square miles, the computation of 400 square miles remains to be completed and the plots of 320 villages still have to be made: these arrears will be brought up by a small detachment under the supervision of Mr. Cooke, as Mr. Little's services are required with the party to which he has been transferred in Burma.*

HOSHANGABAD AND BETUL DISTRICTS, CENTRAL PROVINCES.

No. 13 Party.

337. This party left recess quarters at Poona early in November 1888 and resumed field operations in the Hoshangabad and Betul districts. In order to cope with the large area, with a view to the completion of both these districts this season, in accordance with the requirements of the Chief Commissioner of the Central Provinces, the strength of the party was increased by one European assistant and six temporary sub-surveyors. Field work was continued until the first week of June 1889.

Personnel.

Mr. A. D'Souza, Deputy Superintendent, 4th grade, in charge.
„ A. J. Gibson, Surveyor, 2nd grade.
„ C. W. Wilson, Assistant Surveyor, 1st grade.
„ C. W. F. Seyers, „ „ 1st „
„ T. W. Babonau, „ „ 2nd „ up to 8th April 1889.
„ C. H. G. Johnson, Assistant Surveyor, 3rd grade, from 13th November 1888.
35 sub-surveyors and others.

Temporary Establishment.

14 sub-surveyors and others.

338. The general nature of the operations was the same as that of last year, *viz.*, a system of skeleton traversing along the village boundaries, supplemented, when necessary, with other points within the village lands, so as to furnish a complete frame-work on which a cadastral survey by *patwáris* can hereafter be carried out.

339. An approximate estimate of the country remaining to be surveyed, gave areas of 1,360 and 1,550 square miles in Hoshangabad and Betul respectively; but it was afterwards discovered that in Charwa *pargana* of Hoshangabad, 240 square miles, which had been brought under cultivation during the past 30 years, had not been taken into account, as well as several villages in the reserved forests which had been leased out to cultivators.

340. The section told off to work in the Hoshangabad district succeeded in completing the total area of 1,600 square miles, but, in order to do so, had to remain at work in the field until the 6th June. The Betul section, on the other hand, failed to finish their programme, although the area was somewhat less than that in Hoshangabad; the difficult nature of country, on account of its rugged character, the malarious nature of the hilly portions, and the scarcity of water towards the end of the season, fully account for the smaller out-turn in this tract. In April and May the rivers and streams had dried up, and the only drinking water available was from stagnant pools. Much sickness naturally resulted from this, and at no time had Mr. Seyers, who was supervising the work in these hilly tracts, the continued services of more than two sub-surveyors; he himself suffered severely, and was eventually forced to take three months' leave on his return to recess. By the end of May it was found impossible to carry on work any longer, and the party was allowed to return to Poona, leaving an area of a little over 100 square miles to be completed, which has been made over to No. 9 Party, as No. 13 is under orders to commence the topographical survey of Mergui in Lower Burma.

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* Mr. Little speaks highly of the assistance Mr G. T. Hall rendered him, notwithstanding his ill-health caused by the malarious nature of the country. He also states that Narsoo Dinkar, Abdul Gani, Tufail Ahmed and Burhan Khan have all done well.

341. The following statement shows the out-turn accomplished in each district :—

Districts.	Number of villages.	Number of sub-traverses.	Number of traverse stations.	Area in square miles.	Remarks.
Hoshangabad .	872	1,614	27,278	1,600	In addition to the villages herein returned, eight forest blocks, intermingled with villages, have been surveyed in Hoshangabad and a few in Betul, as well as 34 miles of disputed boundary.
Betul . .	549	906	23,402	1,380	
	1,421	2,520	50,680	2,980	

The out-turn of area shows an increase of 622 square miles over that of the previous season.

342. The demarcation of village boundaries by the civil authorities was quite satisfactory, and the boundary traverses were carried on without impediment, more especially in Hoshangabad ; the tri-junctions, which were found marked with masonry pillars, were invariably utilised as theodolite stations, as well as a large number of the permanent stones marking the bends of the boundaries. To mark the interior traverse stations, stones had to be quarried and transported to the different villages, sometimes over considerable distances. In the neighbourhood of the hills, stones were more easily obtained, and in many instances the *malguzars* voluntarily supplied them. Similar arrangements were made in both the districts under survey. Sketch maps, showing the position of all the traverse stations, have been supplied to the headmen of the different villages, and all the permanent boundary stones, which have been used as theodolite stations, have been placed in their charge, receipts having been taken for the same.

343. During the field season, 748 skeleton plots of villages in Hoshangabad and 150 in Betul were supplied to the Settlement officer of each district, and the remaining villages, comprised in 2,025 sheets, were furnished at the close of the recess season.

344. The office work was exceptionally heavy, as the out-turn was large and the recess season was short. Moreover, in addition to the computations and preparation of the records connected with the season's work, a map of the Sambalpur district, on the 2-inch scale for reduction to 1-inch, was prepared for the settlement department from the original cadastral maps made by the *patwáris* and based on the professional traverses.

345. In Hoshangabad the health of the party was, on the whole, good ; there were four deaths, two of which were from sunstroke. In Betul, sickness, principally from malarious fever, was much more prevalent ; six deaths were reported.

346. The recess office of the party was inspected at Poona during July by the Surveyor-General, who found that good progress was being made with the records, and that Mr. D'Souza's management of the party and the arrangements made for dealing with the large amount of office work were very creditable.*

* Mr. A. J. Gibson is most favourably mentioned by Mr. D'Souza for his zeal and energy in connection with the superintendence of the Betul section ; Messrs. C. W. Wilson, C. W. F. Seyers, and C. H. G. Johnson, are also well reported on. Amongst the native establishment, Mr. D'Souza reports that Boithram, Abdul Khalik, Mahomed Yusuf, and Hidayatoolah, are worthy of special mention.

GEODETIC.

LATITUDE OPERATIONS.

NOS. 22 AND 23 PARTIES, ASTRONOMICAL.

347. It was found necessary, owing to a paucity of officers, to abandon temporarily the electro-telegraphic longitude operations, which require two trained officers to superintend them, in favour of the latitude operations, for which one only is necessary. These operations were placed under the supervision of Mr. J. Eccles, who was now engaged upon them for the first time. Before leaving Dehra Dún he was fully instructed in all details by Captain Burrard, R.E., who had had previous experience with the Zenith Sector used for this class of observations. Seven stations were observed at in all, situated on the Jubbulpore meridional series of the Great Trigonometrical Survey, between the latitudes of 19° 49½′ and 16° 26′ and near the meridian of 80°. The results obtained are of about the same order of accuracy as usual, the probable errors, which are generally considered as the best test of accurate observing, ranging from ±0·040″ to ± 0·057″, the average being ±0·048″ as against ±0·050″ obtained in 1886-87, when this instrument was last used in the field.

Personnel.

Mr. J. Eccles, M.A., Officiating Deputy Superintendent, 4th grade, in charge up to 3rd May 1889.

Captain S. G. Burrard, R.E., Deputy Superintendent, 4th grade, in charge from 4th May 1889.

Harsahai, Recorder.

348. The programme of the observations was essentially the same as in previous years, differing only in minor details. For instance, at some of the stations, owing to the paucity of well-catalogued south stars, it was not found possible to adhere rigorously to the rule of observing the same number of stars north and south of the zenith; again, a departure from the usual programme was made at Bolíkonda and Niálamari, where eight nights' observations with a short programme of 26 stars was accepted, instead of the usual six nights' with 36 stars, and in Mr. Eccles' opinion this change is decidedly advantageous on the score of shorter hours, judging from the fact that at these two stations the probable errors are smallest.

349. In these latitude operations the means of observation furnished by the Zenith Sector used are of such a high order of accuracy, that any small discrepancies in the results may be attributed confidently in most cases to inaccuracies in the catalogued places of the stars employed, rather than to inexact observations.

350. To overcome this difficulty the most obvious means is to increase the number of stars observed, without unduly adding to the length of time spent at each station. In future it is proposed to use four different programmes containing 26 stars each on eight nights at each station, with the usual instrumental changes, by which it is hoped to add still further to the accuracy of this class of work.

351. The instrument is reported to have maintained its former idiosyncracies, inasmuch as what is known as the N.-S. equation, alluded to by all previous observers, still exists and has apparently increased considerably since the instrument was used by Captain Burrard in 1886-87. It is characterised by extreme steadiness; it is found not to depend on the zenith distance of the star, nor can it be accounted for by errors in the corrections for refraction, being too large to be thus explained. It appears to be a purely personal error, and it is fortunate, should this be the true solution of the difficulty, that the resulting value of the latitude is in no way affected by it. The differences between the latitudes of the seven stations observed at, as determined astronomically and geodetically, are again very large, and with one exception have the same sign as in season 1886-87. It may be as well here, in order to guard against misconceptions, to state that these differences by no means imply errors or inexactness either in the astronomic or geodetic work, but merely point to local attraction causing deviation of the plumb-line, or some abnormal deviation of the earth's figure, and by their very existence furnish one of the strongest proofs that can be adduced of the necessity of comparing the latitudes obtainable by the two different methods, if any further progress is to be made in the investigation of these extremely interesting phenomena.

352. A table showing the results of the season's observations and a comparison between the astronomical and geodetical latitudes is subjoined :—

Stations.	No. of stars observed.	No. of observations.	N.—S.	E.—W.	Astronomical Latitude λO	Geodetical Latitude λC	λO—λC = apparent attraction of Plumb-line.
					° ′ ″	° ′ ″	″
Díwai . .	74	204	—1·12	—·000	19 49 26·90±·054	19 49 32·57	—5·67
Ankora .	71	212	—0·99	—·152	19 24 26·68±·052	19 24 34·75	—8·07
Burgpaili .	71	211	—1·05	—·118	18 54 3·51±·050	18 54 7·20	—3·69
Rámgír .	69	208	—0·86	—·117	18 35 26·96±·044	18 35 26·12	+0·84
Bolíkonda .	74	204	—0·87	—·218	17 42 29·12±·042	17 42 35·82	—6·70
Niálamari .	72	211	—1·07	—·005	17 1 25·96±·040	17 1 33·63	—7·67
Dhúlipalla .	57	210	—1·07	—·055	16 25 53·48±·057	16 25 56·75	—3·27

The greater part of the computations of the season's work was completed under the superintendence of Captain Burrard, R.E., during the three months that Mr. Eccles was absent on privilege leave.*

TIDAL AND LEVELLING OPERATIONS.

No. 25 Party.

353. The direction of these operations remained in the hands of Lieutenant-Colonel M. W. Rogers, R.E., until the 6th May 1889, when he was appointed Assistant Surveyor-General, and Mr. G. Belcham was put in charge. Mr. Eccles assisted Colonel Rogers until the 31st October 1888, when the former officer was transferred to the charge of the Astronomical Parties.

Personnel.

Lieutenant-Colonel M. W. Rogers, R.E., Deputy Superintendent, 2nd grade, in charge up to 6th May 1889.
Mr. J. Eccles, M.A., Officiating Deputy Superintendent, 4th grade, attached to the party up to 31st October 1888.
Mr. G. Belcham, Surveyor, 2nd grade, in charge from 7th May 1889.
Mr. E. J. Connor, Surveyor, 4th grade.
Mr. J. Bond, Surveyor, 4th grade.

Tidal Operations.

354. The recording of the tidal curves by means of self-registering tide gauges, their reduction and the publication of predicted heights have been continued, and tidal observations have been carried on during the year at eighteen stations, *viz., Aden, Kurrachee,* Bhávnagar, *Bombay* (Apollo Bunder), *Bombay* (Prince's Dock), Mormugáo (Goa), Cochin, Colombo, Galle, Tuticorin, *Madras,* Cocanada, *Kidderpore,* Chittagong, Akyab, *Rangoon,* Mergui and *Port Blair.* The ten tidal stations, the names of which are not italicised, are minor stations, at which, as a rule, only five years' registrations are required, after the completion of which the instruments are removed. The eight others are permanent stations, where tidal observations have to be continued until the whole scheme of tidal operations has been completed.

355. Since the date of the last report, work has ceased at one station, *viz.,* Mormugáo (Goa), where five years' observations were completed on the 27th March 1889. At Colombo and Galle also, five years' observations have been completed, but as it was considered desirable to continue the observations for another year the instruments were not removed. One new tidal observatory has been established at the minor tidal station of Mergui, where the instruments formerly used at Diamond Harbour, were started on the 24th March 1889.

356. Thus, since the resumption of the systematic tidal operations in 1877, observations have been taken at twenty-nine tidal observatories, of which twelve have been closed on the completion of their registrations and seventeen are now in operation.

357. Arrangements are being made to start an observatory at Shiyálbet (Sálbet), on the southern coast of Káthiáwár, at a site selected by Colonel Rogers: next year steps will be taken to establish tidal observatories at Diamond

* Mr. Eccles speaks very highly of the services rendered by Babus Harsahai and Balwant Joshi, and by Ithu Tindal.

Island in Burma, Trincomalee in Ceylon and Minicoy in the Indian Ocean. Only one set of instruments will then remain unemployed.

358. All the observatories at work have been inspected during the year. A detailed report on the working of each observatory will be found in the appendix. The registrations have been very satisfactory, but there have been a few temporary failures, which must be regarded as inevitable; the clerks have worked well, and the Port Engineers and Port Officers have co-operated most heartily in the work.

359. The reductions of the tidal observations have been carried on steadily during the year, a larger amount having been completed than in any previous year. The observations for one year at ten ports and for two years at five ports have been reduced,—equivalent in all to the reduction of the observations for one year at twenty ports. The tabulated values of the tidal constants obtained from these observations will be found in the appendix.

360. The data also for the tide-tables for 1890 have been computed. These tables will contain predictions of heights and times of high and low water for thirty ports, being two more than the number published in 1889.

361. The computations of the meteorological observations have not been carried on, as owing to the absence of Mr. Eccles, who undertook them, the best method of reduction and application of their results to the tides has not yet been determined.

362. The results of the predictions for 1888 may be summarised as follows:—

Percentage of predictions within 15 minutes of actuals.

	High water per cent.	Low water per cent.
12 Open Coast Stations	72	70
5 Riverain Stations	61	59

Percentage of predictions within 8 inches in height of actuals.

	High water per cent.	Low water per cent.
12 Open Coast Stations	98	96
5 Riverain Stations	70	62

When the tides at a number of new stations are compared with the predictions based on only a year's observations, as is the case this year with the stations of Bhávnagar, Cochin, Cocanada and Chittagong, the discrepancies are not only larger in magnitude but also greater in number. The foregoing results, however, compare favourably with those obtained in former years and show that Mr. Roberts of the Nautical Almanac Office is making steady progress year by year in his efforts to bring his predictions into satisfactory agreement with the actuals.

363. A table of average errors of time in minutes and of height in terms of the range at seventeen ports for 1888 is given in the appendix, from which a better idea of the relative values of the predictions may be gained as explained in paragraph 281 of the report for 1886-87.

SPIRIT-LEVELLING OPERATIONS.

364. The levelling operations were carried on during the year as under:—

Section I.—From the Bangalore Base to Mangalore.

Section II.—From Bidar to Hyderabad (Deccan).

The total out-turn of field-work amounted to 323 miles of double levelling, in the course of which the heights of 315 permanent bench-marks and nine stations of the Great Trigonometrical Survey of India have been determined.

365. It is intended to run a line of levels next season from Hyderabad (Deccan), where the second section closed, to Bezváda near Guntúr and thus complete last year's programme, which it was found impossible to finish before the close of the season, and another line from Novanar in Cutch *viâ* Lakhpat to Tatta in Sind.*

* Mr. Belcham reports most favourably on the work done by Messrs. Connor and Bond, the former in the tidal and the latter in the spirit-levelling operations, and also commends sub-surveyors Narsing Das and Dhonda Venayek.

GEOGRAPHICAL SURVEYS.

OPERATIONS IN UPPER BURMA.

NO. 21 PARTY.

366. This party has continued under the superintendence of Major J. R. Hobday, S.C., and its operations have been similar to those performed during the preceding two seasons, *viz.*, reconnaissance surveys on the scale of 4 miles = 1 inch, carried on in connection with the military expeditions which were organized during the year, each of which was accompanied by one or more of the officers and surveyors attached to the party.

Personnel.

Major J. R. Hobday, S.C., Deputy Superintendent, 4th grade, in charge.
Captain H. M. Jackson, R.E., Deputy Superintendent, 4th grade.
Lieutenant T. F. B. Renny-Tailyour, R.E., Assistant Superintendent, 1st grade.
Mr. M. J. Ogle, Surveyor, 2nd grade.
„ A. G. Wyatt, „ 2nd „
„ F. Kitchen. „ 4th „
„ J. M. Kennedy, Assistant Surveyor, 1st grade.

Sub-Surveyors.

Sher Shah, Bapu Jadu, Faida Ali, Goburdhan Dass, Mohamed Hossein, Ali Nawaz Khan and 6 others.

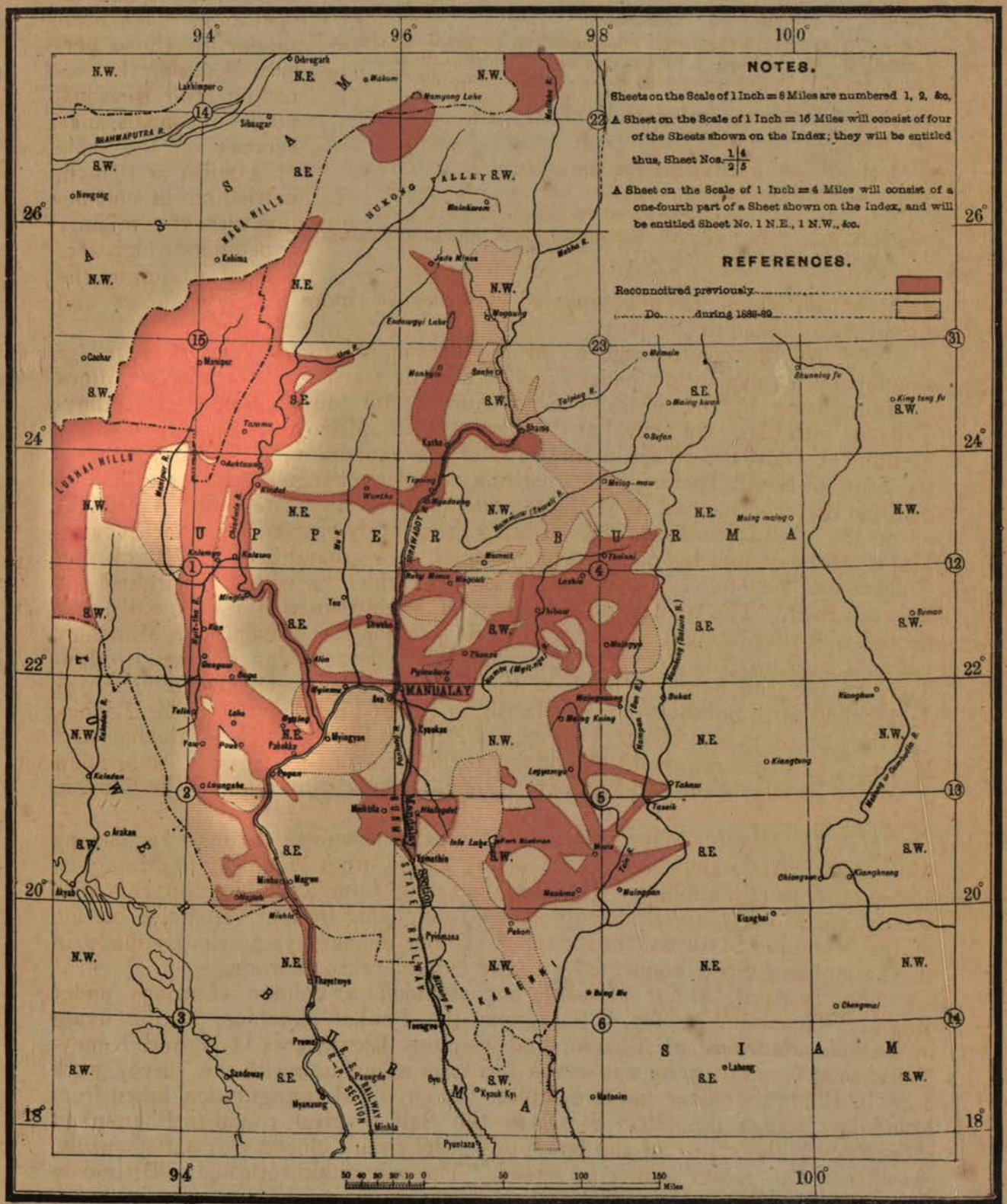
367. At the commencement of the season, Major Hobday arranged to accompany an expedition under Lieutenant Daly starting from the Ruby Mines to Taungbaing in the northern Shan States, and to take Lieutenant Renny-Tailyour with him. On arrival at the starting point, Mogok, news was received by Lieutenant Daly, the officer in command of the expedition, of a disturbance in the State of South Theinni, which led to a complete change of plans, and the expedition marched instead to Maingyè, the capital of the State, which was reached on the 25th December 1888. During the military operations which followed, Major Hobday and his party traversed much new ground between Mogok and Thibaw, and beyond Lolin towards Tangyan, which is within a march of the Salween river. The triangulation was much strengthened and eventually connected with that brought round by Captain Jackson last season from Mandalay, *viâ* Fort Stedman and Legya to Maingyè. The detachment returned to Mandalay on the 2nd February, and on the 8th, Lieutenant Renny-Tailyour was despatched with Sub-Surveyor Faida Ali to rejoin Lieutenant Daly at Lashio, and they accompanied him to Theinni, *viâ* Namsan (Taungbaing), Namkham and Meungsi, and then returned to Mandalay at the close of the season. An account of Major Hobday's and of Lieutenant Renny-Tailyour's journeys will be found in the appendix.

368. In March, Major Hobday detailed one sub-surveyor to accompany Mr. Hörst, Assistant Superintendent of Police, from Mandalay to Mainglon, and another to join a military expedition starting from Twin-Ngé on the Irrawaddy, *viâ* Momeit, to Binbaung on the Taungbaing frontier. A large portion of the Mainglon State was thus mapped in, and the surveys previously made in the Taungbaing State connected with the current season's work.

369. In April, Major Hobday accompanied a column of troops under Brigadier-General Wolseley, C.B., against the Ponkan Kachins, a tribe living in the hills south-east of Bhamo, and meeting Lieutenants Daly and Renny-Tailyour at Namkham, he was enabled to form a junction with the survey work done by the latter officer and to complete the circuit of triangulation taken from Mandalay across the Shan States to the Salween river, round to Bhamo and thence down the valley of the Irrawaddy; the circuit closed very satisfactorily, considering the great distance traversed. The expedition returned to Bhamo on the 4th May 1889.

370. Captain Jackson and Sub-Surveyor Mohamed Hossein accompanied the Karen Field Force under Brigadier-General Collett, C.B., from Mobyé to Sawlon (Sawlapaw's capital), including the reconnaissances to Ywathit and Bawliké, whilst Sub-Surveyor Ali Nawaz Khan accompanied the troops under Major Harvey up the Salween valley from Papun to Pazaung. Although the two columns never met, a satisfactory survey junction was effected by the identification of common points determined by both parties. The good services

INDEX TO THE TOPOGRAPHICAL SURVEYS IN UPPER BURMA.


NOTES.
Sheets on the Scale of 1 Inch = 8 Miles are numbered 1, 2, &c.
A Sheet on the Scale of 1 Inch = 16 Miles will consist of four of the Sheets shown on the Index; they will be entitled thus, Sheet Nos. 1/2 4/5
A Sheet on the Scale of 1 Inch = 4 Miles will consist of a one-fourth part of a Sheet shown on the Index, and will be entitled Sheet No. 1 N.E., 1 N.W., &c.
REFERENCES.
Reconnoitred previously.
Do. during 1888-89.
94°
96°
98°
100°
26°
24°
22°
20°
18°
UPPER BURMA
MANDALAY
SIAM
ASSAM
NAGA HILLS
HUKONG VALLEY
LUSHAI HILLS
BRAHMAPUTRA R.
IRRAWADDY R.
Dehrugarh
Lakhimpur
Sibsagar
Namyong Lake
Mahka R.
Nowgong
Kohima
Jade Mines
Endawgyi Lake
Wuntho
Katha
Bhamo
Momeik
Stunning fu
King tong fu
Sefan
Maing kwan
Maing maing
Tagaung
Shwebo
Ye-u
Monywa
Thazi
Meiktila
Yenangyaung
Yenangyat
Lenya
Pakokku
Myingyan
Pagan
Yamethin
Kyaukse
Sagaing
Ava
Tabayin
Tsaseik
Kiangkhong
Kiangtung
Chiangsen
Kiangkai
Chengmai
Lakeng
Katoein
Pyuntaza
Minhla
Prome
Pegu
Thayetmyo
Sandoway
Akyab
Arakan
Loungshe
Kaleden
Mingin
Mingin
Mingin

rendered by Captain Jackson in this expedition have been acknowledged by Major-General Sir George White and Brigadier-General Collett in their despatches. An interesting description of Captain Jackson's travels will be found in the appendix.

371. After the break-up of the Karen Field Force, Captain Jackson assisted Mr. Hildebrand, the Superintendent of the Shan States, in demarcating the boundary between Mobyè and Karenni. After this, he and Sub-Surveyor Mohamed Hossein succeeded in completing the detail survey of the Myelat from Pekon to Baw, and extended the survey to Yatsauk and northwards, returning by the eastern road to the Enlè valley. He then completed the survey of the small states of Kyauktat and Bawzein and finally returned to Yamethin by the Taung-hla road.

372. Mr. Kennedy, Sub-Surveyor Ramsabád Misser and an apprentice, were deputed to accompany the Chin Field Force under Brigadier-General Faunce, but owing to some misunderstanding and professed inability on the part of the military officials on the spot to supply escorts and rations to the party, it was left behind when the first advance was made from Kambalè. On his return from the Shan States early in February, Major Hobday found Mr. Kennedy and his party still in the Myit-tha valley, and reported the matter to Sir George White, who issued immediate orders for Mr. Kennedy to be sent on to the front. Fortunately the troops had not moved about much before his arrival, so that when the reconnaissances were made the surveyors had joined and were available to accompany them, and the whole country traversed by the troops, though not a very large area, was successfully surveyed.

373. Mr. Ogle and Sub-Surveyor Bapu Jadu accompanied the several expeditions under Lieutenant O'Donnell from Mogoung against the Kachin tribes in that locality, and a large area of useful and interesting geography of these distant regions was obtained. A perusal of Mr. Ogle's diary, which will be found in the appendix, will show the amount of hard work done by this column and the survey party.

374. Mr. Wyatt and Sub-Surveyors Mohamed Latif, Abdul Rahman and Mohamed Sayed completed the detail survey of the Minbu district, while Mr. Kitchen and Sub-Surveyors Gobardhan Dass and Abdul Rahim succeeded in mapping about half of the Myingyan district. The survey of the southern half of this district could not be effected owing to its disturbed state; most of the military police of the district were engaged in active operations against the dacoits in this locality, and escorts for the survey parties could not be furnished in consequence. For this reason Mr. Kitchen and his party were transferred to the Sagaing district, about half of which was then surveyed, *viz.*, the portion that falls on the left bank of the Irrawaddy.

375. The following areas give the result of the past season's surveys in Upper Burma :—

	Sq. miles.
Northern Shan States	3,950
Southern ditto	5,300
Bhamo District	3,940
Ruby Mines do.	420
Myingyan and Sagaing Districts	2,140
Upper Chindwin (Chin Hills)	1,620
Minbu District	3,140
Total Area	20,510

376. During the three years that survey operations have been carried on in Upper Burma, an aggregate area of 52,290 square miles of new country has been mapped. Major Hobday has superintended the operations throughout. He has been ably supported by Captain Jackson, R.E., and to the untiring energy and zeal of these two officers, the chief credit of this large result is due. The work has been extremely onerous, involving considerable exposure. The surveyors and subordinates are also deserving of much praise for their share in the work, and it is pleasing to report that Mr. Ogle has been awarded the Gill Memorial by the Royal Geographical Society for survey work in Eastern Assam, Manipur, and Northern and Western Burma.

377. Advantage was taken of Lieutenant-Colonel Strahan's deputation to

Burma for the purpose of conferring with the local authorities on future surveys, to inspect the recess office of this party. The nature of the work done involves a great deal of fair mapping which requires to be turned out in the shortest possible time, and the necessity of carrying on the triangulation *pari passu* with the detail work involves contant alteration and revision of the computations. Colonel Strahan reports that all this has been most satisfactorily carried out, and that the office work has been kept well up to the field work.*

OPERATIONS WITH THE LUSHAI EXPEDITION.

378. The Military expedition to the Lushai Hills which took place in the cold season of 1888-89 was accompanied by a Survey detachment composed of Lieutenant W. H. Pollen, R.E., in charge, Mr. A. J. James, Surveyor, 4th grade, and Sub-Surveyor Ikbaludin.

379. The detachment arrived at Chittagong on the 12th January and at Demagiri on the 19th. The remainder of the month was occupied in taking observations to extend the triangulation from the Sirtag and Uiphum hill stations. It was arranged that Lieutenant Pollen should devote his time to triangulation while Mr. James and the sub-surveyor carried on the topographical survey and a plane-table traverse of the road under construction between Demagiri and Lungleh.

380. During the expedition Lieutenant Pollen triangulated 675 square miles of country, observing at 4 stations, from which 16 tertiary points were fixed and 4 heights determined. Considering the short time his health allowed him to work, this out-turn is a very large one. The total area topographically delineated was 540 square miles, besides which about 210 square miles was roughly reconnoitred from long distances. The line of new road from Demagiri stockade to Lungleh was surveyed by plane-table traverse and measured 43 miles.

381. Lieutenant Pollen was unfortunately attacked by malarious fever on the 20th February, which never left him. When his illness first commenced, he was advised by several officers to return from the front to obtain rest and skilled medical treatment. This, however, he refused to do, and he remained at his post until the 10th March, when he was invalided and sent back to Chittagong under the care of Dr. Bell of the Indian Medical Service. There he grew rapidly worse, and eventually succumbed to the fever on the 26th March. The Officer Commanding Lushai Expeditionary Force in his despatch on the operations thus alludes to the untimely death of this young officer, coupled with that of another officer who died shortly after Lieutenant Pollen:—"In the death of these very promising young officers, the service has lost two hard-working, energetic and zealous soldiers, both of whom had made themselves great favourites with the force."

382. Mr. James, upon whom the charge of the detachment devolved, also suffered severely from fever and sore-eyes, which prevented him accompanying the troops in their advance from Lungleh to Howsata's village, and unfortunately the sub-surveyor's services were not utilized for the excursion as they should have been, when more geographical information might have been gained.

383. The work done, though not great in quantity, adds a fair amount of new knowledge of the country. The principal fact ascertained is that there is no large stream or main feeder to the Kaladan (Koladyne) River between the Blue Mountain (Mal Selai Mon) and Darjow Klang, as shown in the old map of the country. The principal stream flows much further north between Aitur Klang and Maliam Pui Klang. The Matt river joins the Kaladan further south than is shown in the old map. The sites of several new villages have been laid down and the positions of others corrected.

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*Of his assistants Major Hobday reports as follows:—

"Captain Jackson has worked with his usual zeal and energy. When with the Karen column he was wounded whilst taking part in a charge of mounted infantry against the enemy and had a narrow escape in a personal encounter with a Shan.

"Lieutenant Renny-Tailyour has rapidly learnt all the duties of his profession, and during this his first field season has done a very creditable triangulation over a difficult country.

"The surveyors and assistants have all worked well, Mr. Ogle especially so.

"The sub-surveyors deserving of especial mention are Faida Ali, Bapu Jadu, Mohamed Hossein and Gobardhan Dass."

TRANS-FRONTIER EXPLORATIONS.

384. The explorations carried on during the year on the northern frontier of India were confined to a reconnaissance made by Sub-Surveyor Rinzin Nimgyal from stations in the vicinity of Sadiya in Eastern Assam. He was ordered to verify as far as possible, either from actual observation or from information furnished on the spot by travellers, the geographical data gleaned by explorer K. P. during his residence in the Pemakoi country and in his reported journey down the Sangpo river. The result of Rinzin's enquiries is embodied in a new map of the country adjacent to the lower course of the Sangpo, from Gyala Sindong to the plains of India, including the drainage area of the Dibong. The chief alterations made in the map published in the Annual Report of 1886-87 are as follows :—

(*a*) Miri Padam or Damroh Padam, which was placed by K. P. in the Dihong Valley and only four or five miles from its left bank, is now found to occupy a position some four or five miles from the left bank of the Zyul Chhu or Yang Song (called by the Abors, the Abor or Yamne river) nearly twenty miles from the confluence of the Dihong and Yang Song rivers, instead of four miles below that point as stated by K. P.

(*b*) The general course of the Dibong (called by the Abors the Shiang) from Gyala Sindong to its debouchment in the plains of Assam is much straightened below Bepung of K. P., from which place the river is now shown to flow generally south-east instead of south.

(*c*) The drainage area of the Zyul or Yang Song Chhu has been much curtailed by making the head waters of the Dibong tap the mountains to the west of A. K. 's Shiuden monastery.

(*d*) The information furnished to Rinzin with respect to the course of the Dibong is quite at variance with that which was accepted by Colonel Tanner last year. The Abors stated to Rinzin that the river rises in a high glacier-covered country, far to the north of the range laid down by the late Captain Harman on his sketch map. In fact Rinzin's new map makes the Dibong cut through Captain Harman's range and gives it a course more in conformity with General Walker's opinion as expressed by him in his paper on the Hydrography of South-Eastern Tibet which was published in the proceedings of the Royal Geographical Society, September 1888, and makes Captain Harman's measured discharge of the Dibong more in accordance with the extent of its drainage area. This matter was treated on by Colonel Tanner in the last Annual Report (Appendix, p. XLVIII), but though he accepted Captain Harman's rough reconnaissance of the lower course of the Dibong, he, at the same time, pointed out that the reliable information of the localities round the Dihong and Dibong rivers is so meagre that a long series of contradictory maps must be looked for, constructed from time to time from conjecture, until authentic information of the courses of these great rivers is obtained.

385. In the appendix, page xlv, will be found some notes by the sub-surveyor regarding the information he obtained.

Summary of the Out-turn of Work of the

Scale of Survey.	Number of Party.	Locale of Field Operations.		TRIANGULATION.													
				Instrument used.	Area triangulated in square miles.	Number of stations at which observations were taken.	Number of square miles to each point trigonometrically fixed.	Number of square miles to each height.	Secondary—in which each angle is usually observed on two zeros.					Tertiary—in which two angles of each triangle are observed.			
									Number of stations fixed.	Number of triangles.	Triangular error in seconds.	Error per mile in feet.	Number of heights.	Number of intersected points fixed.	Number of triangles.	Error per mile in feet.	Number of heights.
50 feet = 1 inch 64 inches = 1 mile	8	City of Calcutta	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	7	Town of Yandun		...	...	...	...	...	...	...	...	...	...	...	...	...	...
16 inches = 1 mile	2	Bilaspur		...	...	...	...	...	...	...	...	...	...	...	...	...	...
	3	Nagpur and Wardha		...	...	...	...	...	...	...	...	...	...	...	...	...	...
	4	Jalpaiguri	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	4a	Srinagar Estate		...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Burdwan Khas Mehals		...	...	...	...	...	...	...	...	...	...	...	...	...	...
	5	Jhansi		...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Lalitpur		....	...	...	...	...	...	...	...	...	...	...	...	...	...
		Tarai	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Bhabar		...	...	...	...	...	...	...	...	...	...	...	...	...	...
	6	Sibsagar		...	...	...	...	...	...	...	...	...	...	...	...	...	...
	7	Thongwa		...	...	...	...	...	...	...	...	...	...	...	...	...	...
	8	Sankarpur Estate		...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Maldwar	15	...	...	...	...	...	...	..	...	...	...	...	...	...	...
		Angul		...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Kujang		...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Kanika		...	...	...	...	...	...	...	...	...	...	...	...	...	...
	9	Chanda		...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Bhandara	20	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	11	Nimar		...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Chhindwara		...	...	...	...	...	...	...	...	...	...	...	...	...	...
	12	Saugor		...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Balaghat		...	...	...	...	...	...	...	...	...	...	...	...	...	...
	13	Hoshangabad	25	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Betul		...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Detachment.	Chittagong		...	...	...	...	...	...	...	...	...	...	...	...	...	...
8 inches = 1 mile	5	Jhansi (Forests)		...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Lalitpur (do.)		...	...	...	...	...	...	...	...	...	...	...	...	...	...
	17	Bombay (do.)	30	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4 inches = 1 mile	5	Tarai (Forests)		...	...	...	...	...	...	...	...	...	...	...	...	...	...
	8	Kujang		...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Kanika		...	...	..	...	...	...	...	...	...	...	...	...	...	...
	14	Hoshangabad		6″	402	90	0·9	0·9	60	125	20	0·70	67	383	716	0·8	377(*e*)
	17	Bombay (Forests)	35	6″ & 7″	386	181	3·0	3·0	134	324	11	0·57	134	427	741	...	281
	18	Himalayas		5″, 6″, 10″ & 12″	1,606(*f*)	175	2·0	2·0	105	278	17	0·50	105	788	402(*g*)	1·2	788(*h*)
	19	Madras (Forests)		4½″, 5″ & 6″	1,144	95	1·7	1·7	85	282	19	0·36	88	451	900	0·8	407
	20	Burma (do.)		5″ & 6″	210	15	9·8	10·3	10	15	5	0·40	10	8	9	...	2
2 inches = 1 mile	1	Punjab		5″, 6″ & 7″	...	...	...	...	...	...	...	...	...	...	...	...	...
	7	Akyab	40	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	8	Angul (Jungle tracts)		...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Do. (Forests)		...	...	...	...	...	...	...	...	...	...	...	...	...	...
	10	South Maratha country		5″, 6″ & 7″	1,950	130	9	9	78	202	6	0·40	58	129	210	0·4	83
		Gujarat		...	1,460	84	2	2	84	244	8	0·40	169	634	668	0·5	521
	15	Baluchistan	45	6″ & 8″	1,460	79	4	4	51	159	9	0·30	51	356	568	0·7	323
	18	Himalayas		...	...	...	...	...	...	...	...	...	...	...	...	...	...
	20	Burma		...	...	...	...	...	...	...	...	...	...	...	...	...	...
1 inch = 1 mile	1	Punjab		...	...	...	...	...	...	...	...	...	...	...	...	...	...
½ inch = 1 mile	15	Baluchistan		...	...	...	...	...	...	...	...	...	...	...	...	...	...
¼ inch = 1 mile.	15	Baluchistan	50	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	21	Upper Burma		...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Detachment.	Lushai Hills		...	675	...	...	...	...	...	...	...	...	...	...	...	...
	15	Baluchistan		15¾″	3,000	13	230	230	13	16	2·46	0·04	12	...	...	...	...
	24	Burma Coast		...	...	...	...	...	...	...	...	...	...	...	...	...	...
	25	Madras	55	...	...	...	...	...	...	...	...	...	...	...	...	...	...

Field Parties during the year 1888-89.

	SPIRIT-LEVELLING OPERATIONS.				TRAVERSING.					TOPOGRAPHY.						Remarks.
	Number of miles levelled over.	Number of permanent bench-mark stones embedded.	Number of Trigonometrical stations connected with lines of levels.	Number of permanent points fixed as bench marks.	Number of stations at which theodolite was set up.	Linear miles.	Average angular error per station in seconds.	Average linear error per *mille*.	Square miles of village survey.	Area in square miles.	Average number of plane-table fixings per square mile.	Number of linear miles of test lines.	Number of villages.	Number of fields.	Average size of fields in acres.	
1	...	...	...	...	...	...	...	...	...	0·90	...	...	...	...	...	(*a*) Includes 241 square miles of Native States.
	...	...	...	...	...	...	...	...	...	0·72	...	...	...	...	...	(*b*) Calculated on cultivated portion only.
	...	...	...	...	...	...	...	...	...	915	...	1,805	541	1,722,295	0·23	(*c*) In addition 5,040 heights were determined with the tangent scale clinometer.
	...	...	...	...	47,132	5,458	3	0·4	3,348	...	...	...	1,808	...	...	
5	...	...	...	...	11,951	2,024	3	0·2	450	208	...	583	323	278,860	0·48	(*d*) This represents 349 square miles.
	...	...	...	...	...	403	3	0·4	39	258	...	...	371	197,524	0·83	
	...	...	...	...	...	...	...	...	243	127	...	...	243	284,140	0·30	(*e*) Besides this 35·6 square miles of detail survey, done in outline only during season 1887-88, were contoured.
	...	...	...	...	13,474	2,114	2	0·1	935(*a*)	1,059	...	4,106	499	454,349	1·44	
	...	...	...	...	22,742	3,953	...	...	1,200	...	...	...	447	...	...	
10	...	...	...	...	1,005	222	...	...	241	61	...	305	58	14,479	2·69	
	...	...	...	...	6,968	1,008	...	...	142	83	...	562	331	37,294	1·41	
	...	...	...	...	9,364	1,832	3	0·2	552	657	...	...	627	369,987	1·14	
	...	...	...	...	12,940	3,457	1	0·1	1,076	826	...	1,287	265	465,328	0·37(*b*)	
	...	...	...	...	...	...	...	...	...	20	...	50	35	12,588	0·02	(*f*) Includes area for 2" survey.
5	...	...	...	...	...	...	...	...	...	15	...	36	36	31,739	0·30	
	...	...	...	...	...	...	...	...	...	177	...	469	165	70,262	1·61	
	...	...	...	...	4,871	1,240	4	0·1	150	199	...	1,075	420	157,807	0·81	(*g*) The remainder are in course of computation.
	...	...	...	...	7,354	1,312	2	0·3	438	16	...	46	47	10,253	1·00	
	...	...	...	...	33,440	6,019	6	0·1	2,709	...	...	...	993	...	...	
20	...	...	...	...	16,375	4,975	6	0·1	1,763	...	...	...	914	...	...	(*h*) A very large number determined for the 2,202 miles of surveyed contours.
	...	...	...	...	22,216	3,422	7	0·4	1,736	...	...	...	705	...	...	
	...	...	...	...	6,693	1,175	...	...	484	...	...	...	262	...	...	
	...	...	...	...	25,146	4,826	7	0·5	1,771	...	...	...	930	...	...	
	...	...	...	...	28,214	4,361	...	...	1,300	...	...	...	699	...	...	
25	...	...	...	...	27,278	4,564	3	0·5	1,600	...	...	...	872	...	...	(*i*) This represents 228 square miles.
	...	...	...	...	23,402	3,622	5	0·5	1,380	...	...	...	549	...	...	
	...	...	...	...	...	...	1	0·3	244	215	...	184	46	406,133	0·16(*b*)	(*j*) Thirty-one plane-tables tested by *in situ* fixings or by the bar subtense method.
	...	...	...	...	...	...	...	...	50	...	...	...				
	...	...	...	...	...	...	...	...	33	...	...	...	...	...	...	(*k*) Includes 2,748 square miles of area tested only and maps compiled from Surveys by settlement department.
30	...	...	...	...	...	...	...	...	...	22	241	39	...	...	...	
													...	...	...	
	...	...	...	...	...	...	...	...	...	159	...	...	...	...	...	(*l*) Eleven verificatory azimuths were also observed.
	...	...	...	...	...	...	...	...	...	133	...	...	...	...	...	
	...	...	...	...	...	...	...	...	...	50	...	...	...	...	...	
	...	...	...	...	1,878	217(*d*)	9	2·0	...	308(*e*)	134	176	...	...	...	
35	...	...	...	...	6,650	1,350	7	0·9	...	633	54	...	...	...	...	
	...	...	...	...	2,731	597(*i*)	21	0·6	...	215	34	(*j*)	...	...	...	
	...	...	...	...	3,168	240	13	1·7	...	168	32	...	...	...	...	
	...	...	...	...	6,967	4,317	9	8·0	...	150	175	39	...	...	...	
	...	...	...	...	19,696	8,620	5	0·7	7,308	3,446(*k*)	...	257	...	...	...	
40	...	...	...	...	...	...	...	...	17	17	...	...	...	...	...	
	...	...	...	...	...	...	...	...	...	69	...	...	...	...	...	
	...	...	...	...	...	...	...	...	...	215	...	...	...	...	...	
	...	...	...	...	2,793	971	3	0·5	...	1,542	30	260	...	...	...	
	...	...	...	...	...	...	...	...	...	1,109	22	125	...	...	...	
45	...	...	...	...	...	...	...	...	...	968	13	...	...	...	...	
	...	...	...	...	...	...	...	...	...	358	40	(*j*)	...	...	...	
	...	...	...	...	...	...	...	...	...	162	53	21	...	...	...	
	...	...	...	...	...	...	...	...	...	70	...	...	...	...	...	
	...	...	...	...	...	...	...	...	...	3,628	1·04	...	...	...	...	
50	...	...	...	...	...	...	...	...	...	1,100	...	...	...	...	...	
	...	...	...	...	...	...	...	...	...	20,510	...	...	...	...	...	
	...	...	...	...	...	...	...	...	...	540	...	...	...	...	...	
	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	} Trigonometrical operations only.
	...	...	...	...	294(*l*)	157	4	0·3	...	...	...	...	...	...	...	
55	323	33	9	282	...	...	...	...	...	...	...	...	...	...	...	

Statement showing the Cost-rates of work executed by the

Number of Party.	Nature and *locale* of Field Operations.	Cost-rate per square mile in Rupees.							
		Triangulation.	Traversing.	Detail Survey on Scales of					
				½″	1″	2″	4″	8″	16″
	Topographical Surveys.								
10	Belgaum	5·0	1·9	...	...	16·3	...	...	...
	Gujarat	5·5	...	...	...	24·0	...	...	...
15	Baluchistan	12·8	...	...	...	45·5	...	...	...
		...	...	4·5	...	...			
18	Himalayas	3·0	30·4	...	...	...	129·1	...	...
		7·4	...	...	...	62·4	...		
	Forest Surveys.								
5	Tarai	...	...	...	...	...	51·9	...	...
8	Angul	...	...	...	...	40·4	...	...	...
14	Hoshangabad	15·6	12·9	...	...	...	172·3	...	...
17	Bombay	37·6		...	...	...	...	143·3	...
		24·8		...	...	...	58·8	...	
19	Madras	24·1		...	...	...	137·8	...	...
20	Burma	104·4		...	...	77·7	243·7	...	...
	Cadastral Surveys.								
2	Bilaspur	...	...	...	...	...	...	...	66·5
4	Jalpaiguri	...	63·8	...	...	...	...	...	171·7
4A	Srinagar	...	70·0	...	...	...	...	...	114·2
	Burdwan	...	36·2	...	...	...	...	...	169·7
5	Jhansi	3·8	13·5	...	...	...	...	...	26·3(*h*)
	Tarai	...	17·7	...	...	...	...	...	50·4(*h*)
	Bhabar	...	22·4	...	...	...	...	...	56·4(*h*)
6	Sibsagar	...	31·5	...	...	...	...	...	64·7(*h*)
7	Thongwa	...	58·9	...	...	...	...	...	135·1
8	Sankarpur Estate	...	...	...	...	...	...	...	110·9
	Maldwar „	...	...	...	...	...	...	...	99·4
	Angul, Orissa	...	...	...	...	20·9	...	...	56·8(*h*)
	Kujang, Cuttack	...	43·9	...	...	...	28·6	...	60·3(*h*)
	Kanika	...	31·4	...	...	...	9·7	...	97·2
Det.	Chittagong	...	51·5	...	...	...	...	...	141·1
	Traverse Surveys.								
1	Punjab	...	6·7(*p*)	...	...	6·1(*q*)	...	...	...
3	Nagpur and Wardha	...	25·7	...	...	...	...	...	...
5	Jhansi	...	15·0	...	...	...	...	...	...
	Lalitpur	...	15·1	...	...	...	...	...	...
9	Chanda and Bhandara	...	14·6	...	...	...	...	...	...
11	Chhindwara and Nimar	...	21·4	...	...	...	...	...	...
12	Saugor	...	20·7	...	...	...	...	...	...
	Balaghat	...	22·1	...	...	...	...	...	...
13	Hoshangabad and Betul	...	23·2	...	...	...	...	...	...

several Field Parties during the year 1888-89.

Rate in annas for traversing, detail survey, and preparation of maps.		Cost-rates.					Total cost.	Remarks.
Scale 16″ = 1 mile.		Stone embedding.	Records (*Khanapuri*).		Compilation of Vernacular Records, Assessment Statistics, &c.			
Per acre.	Per field.	Per square mile.	Per square mile.	Per field.	Per square mile.	Per field.		
a. p.	*a. p.*	*R*	*R*	*a. p.*	*R*	*a. p.*	*R*	
...	...	...	...	...	...	...	38,682	(*a*) Includes R3,615 expended on Meywar and Marwar boundary survey, and R747 on completion of forest survey and mapping 8″ scale.
...	...	...	...	...	...	...	38,992(*a*)	
...	...	...	...	...	...	...	1,10,585(*b*)	(*b*) Includes R20,430 expended on trigonometrical operations; R9,636 on special exploration work, and R408 on large scale survey of Quetta.
...	...	...	...	...	...	...	72,212(*c*)	(*c*) Includes R3,603 expended on trans-frontier survey; R2,929 on plotting traverse points for settlement survey; R2,291 on instruction of soldier surveyors, and R202 on instruction of pupils.
...	...	...	...	...	...	...	8,270	(*d*) Includes R3,083 expended in classification of forests and soils of 389 square miles; R4,018 on arrears of triangulation and detail survey of season 1887-88, and R2,565 in bringing up the general report and maps of the Mirzapur survey. It also includes the instruction of four soldier surveyors and 21 pupils.
...	...	...	...	...	...	...	12,354	
...	...	...	...	...	...	...	73,244(*d*)	
...	...	...	...	...	...	...	65,384(*e*)	(*e*) Includes R8,367 expended on advance traversing and triangulation.
...	...	...	...	...	...	...	56,607	(*f*) Includes R1,467 expended on demarcation; R186 on grant survey; R85 on forest boundary survey; R9,579 on completion of Basti maps and records; R3,882 on Chakia and Dudhi maps and records, and R1,014 on leave pay and instruction in surveying.
...	...	...	...	...	...	...	1,07,748	
								(*g*) Includes R3,620 expended on traversing of Native States; R1,196 on instruction of junior civilians, and R21,751 on completion of Gorakhpur records.
1 8	0 6	...	53·8	0 5	...	...	1,10,885	(*h*) The low rate is due to the employment of local agency in lieu of imported *amins* for the field survey.
5 11	2 10	17·9	81 8	1 0	...	...	1,06,095(*f*)	
4 7	3 8	13·0	31·4	0 7	...	...	55,132	(*i*) Includes R1,341 expended on revision work; R1,492 on training of *mandals*, and R2,876 on 2″ mapping.
5 2	2 6	10·9	127·1	1 6	...	...	45,725	
1 0	1 5	...	...	...	...	...	65,610(*g*)	(*j*) Includes R1,516 expended on revision work in Thongwa district; R1,708 on survey of Akyab grants on 16″ scale; R587 on survey of same on 2″ scale, and R985 on 64″ survey of Yandun town.
2 0	5 4	...	...	...	...	...	8,022	
2 0	2 10	...	...	...	...	...	7,839	
2 6	3 3	1·2	16·5	0 7	35·5	1 2	1,00,494(*i*)	
4 10	1 9	...	...	...	...	...	1,79,820(*j*)	(*k*) Includes cost of preparation of trace maps, &c.
8 4	2 7	...	86·3	0 8	...	...	9,791(*k*)	(*l*) Includes R4,264 expended on Banki mapping and settlement of disputed boundaries.
11 0	1 5	...	65·5	0 2	...	...	8,723	
3 11	5 3	...	23·2	0 10	...	...	37,923(*l*)	
2 3	1 10	5·7	28·5	0 7	...	...	36,525(*m*)	(*m*) Includes R1,510 expended on survey school.
2 6	2 6	4·4	...	...	...	...	19,320(*n*)	(*n*) Includes R966 expended on survey schools.
4 10	1 10	6·1	79·0	0 9	...	...	56,760(*o*)	(*o*) Includes R8,828 cost of identification of *maghi daghs*, and R457 for instruction of Bengali *amlas*.
								(*p*) Traversing limited to fixing village boundary tri-junction marks.
								(*q*) Topography not surveyed but obtained by reduction from settlement survey maps; the reduced maps are tested.
...	...	...	...	...	...	...	64,975(*r*)	(*r*) Includes R3,702 expended in traversing and map compilation in Sikh States, and R472 for mapping atlas reductions.
...	...	...	...	...	...	...	85,958	
...	...	...	...	...	...	...	751	(*s*) Includes R11,502 expended on re-survey and bringing up arrears in districts Seoni and Chhindwara.
...	...	...	...	...	...	...	18,099	
...	...	1·5	...	...	...	...	72,140	(*t*) Includes R1,622 expended on tracings of 4″ village maps of districts Balaghat and Saugor, and R2,079 on leave pay of Assistants and Sub-Surveyors.
...	...	1·2	...	...	...	...	61,702(*s*)	
...	...	1·2	...	...	...	...	41,203(*t*)	
...	...	1·8	...	...	...	...	31,037	(*u*) Includes R804 expended on Sambalpur settlement work.
...	...	...	...	...	...	...	70,082(*u*)	

Tabulated Statement of the principal Records prepared in the several Recess Offices of the Field Parties of the Revenue Branch for the year 1888-89.

Number of Party.	Nature of Survey and Locality.	Mapping.						Traverses.		Field Books.		Area Books.		For Settlement Department.		Remarks.
		Original Field Sections.	Cadastral 16-inch sheets.	Sheets, 4 inches = 1 mile $7\frac{1}{2}' \times 3\frac{3}{4}'$	Quarter sheets 2 inches = 1 mile $15' \times 7\frac{1}{2}'$	Index Maps.	Triangulation Charts.	Main circuit with azimuth computations. Vols.	Village or sub-circuit. Vols.	Main circuit. Vols.	Village or sub-circuit. Vols.	Villages.	Fields.	Sheets or tracings.	Village registers (khasras).	
	Cadastral Surveys.															
	North-Western Provinces.															
5	Jhansi	...	1,200	...	...	...	...	2 1 Az.	6	1	12	499	454,349	499	499	In addition, 9 four-inch sheets of district Gorakhpur have been drawn.
	Tarai	...	96	13	...	1	...	...	...	...	...	58	14,479	58	58	
	Kumaon (Bhabhar)	...	215	...	...	...	...	...	...	...	...	331	37,294	331	331	
	Bengal.															
4	Jalpaiguri	391 on 16″ 1 on 4″	391	...	...	1	...	1	5	1	9	Jots 2,223	278,860	2,223	2,223	For Settlement Officer, Jalpaiguri, for each jot, 1 trace map with Bengali khasra, khatian, milan khasra and abstract of khatians, with list of sharers in jots giving the amounts of their shares and agricultural statistics with rough census. Of the milan khasras 444 were prepared. Abstract of khatians of 683 jots were prepared.
4A	Srinagar Estate	...	538	...	...	1	...	3	2	1	1	371	193,381	371	371	In addition, two extra sets of tracings were prepared for the Manager.
8	Dinagepore (Sankarpur Estate)	75 on 16″	...	...	...	1	...	...	2	2	6	35	12,588	35	35	
	Do. (Maldwar Estate)	44 on 16″	...	...	...	1	...	...	2	2	3	36	31,739	36	36	
	Cuttack (Angul Estate)	259 on 16″	...	...	17	1	1	1	5	1	13	165	70,262	398	398	
	Do. (Bánki)	...	...	13	...	1	...	1	1	1	2	6	12,183	15	15	
	Kujang	449 on 16″ 17 on 4″	...	...	...	1	...	...	...	...	...	420	157,807	329	329	
	Kanika	52 on 16″ 5 on 4″	...	...	...	1	...	2 2 Az.	3	2	3	...	...	...	...	
Det.	Chittagong	...	303	...	4	1	...	1 1 Az.	2	1	4	...	...	...	...	2 Area Books.
	Assam.															
6	Sibsagar	899 on 16″	...	...	18	1	...	1 1 Az.	3	1	5	627	369,987	627	627	For Settlement Officer 255 lakhiraj and nisfkhiraj field area statements, and 53 grants. For Deputy Commissioner 203 tracings from 16″ village maps.
	Central Provinces.															
2	Bilaspur	1,115 on 16″	1,115	...	...	...	...	...	...	...	...	544	17,93,671	544	544	

	Burma.																
7	Thongwa	...	987	...	...	...	...	4	4	4	8	265	4,65,328	987 on 16″ 8 on 2″	...	Index map of season's work prepared for Settlement Department on 4 miles=1 inch scale. Copies (in duplicate) on scale of 2 inches =1 mile of plans showing permanent marks in seasons operations, prepared for Deputy Commissioner of Thongwa.
	Bassein	...	....	...	8	...	...	...	...	...	...	...	...	...	...	
	TRAVERSE SURVEYS.																
	Central Provinces.																
3	Nagpur and Wardha	...	3,529	...	...	...	...	2	10	2	32	...	...	Skeleton plots. 3,529	30 Vols. co-ordinate Tables.	
9	Bhandara	...	...	...	...	...	...	1 Az.	12	...	6Sub-cts 6	...	...	3,618	6 Trav. Vols.	
	Chanda	...	...	...	...	...	...	1	9	6	7	...	...		6 Trav. Vols.	
	Raipur	...	...	...	...	...	...	1 Az.	...	...	1	...	...	...	...	
11	Seoni	...	...	...	...	...	...	2 2 Az.	13	2	13	...	...	2,076	...	
	Chhindwara	...	...	...	...	...	...	2 2 Az.	18	2	17	...	...	2,901	...	
	Nimar	...	...	...	...	...	...	1 1 Az.	7	1	1 Sub-ct. 8 Vil.cts.	...	...	1,313	...	
12	Saugor	...	...	...	...	...	...	3 3 Az.	12 1 (Forest)	3	12 1 Offset.	...	...	1,717	...	1 Volume of rectangular co-ordinates, districts Narsinghpur and Saugor, seasons 1886—89.
	Balaghat	...	...	...	...	...	...	2	9	...	16	...	...	1,201	9 Vols.	
13	Hoshangabad	...	1,885	...	...	...	...	3	10	3	13	...	...	1,885	11 Vols. co-ordinate Tables.	
	Betul	...	1,038	...	...	...	...	2	12	1	17	...	...	1,038	10 Vols.	9 circuits unbound to the Deputy Commissioner of Sambalpur.
	TOPOGRAPHICAL SURVEYS.																
	Punjab.																
1	Jhang	49 on 2″	...	...	41	2	...	1	1	1	2	...	...	1 Trav. Vol.	1 Index Chart.	
	Gujranwala	...	...	...				1	2	1	4	...	...	2 Trav. Vols.	1 Index Chart.	
	Sialkot	...	...	...				1	5	1	5	...	...	5 Trav. Vols.	1 Index Chart.	
	Bombay.																
10	Belgaum	26 on 2″	...	...	14	...	4	...	3	...	3	...	...	...	...	2 Vertical Angle Books—4 Horizontal angle books—2 Volumes computation of Triangles.
	Gujarat	20 on 2″	...	...	8	...	1	...	...	...	...	...	...	...	...	2 Vertical Angle-Books—2 Horizontal Angle Books—4 Volumes Computation of Triangles.
	CITY SURVEY.																
8	Calcutta	38 on 50′ =1 inch.	114 on 50′ =1 inch.	...	...	2	...	...	...	...	...	...	...	...	...	

Particulars of Cadastral Surveys completed since 1883-84.

Districts and Estates.	Number of villages.	Number of fields.	Area in square miles.	Average size of fields in acres.	Cost.	Rate per square mile of Cadastral Surveys, with records of rights and statistical statements.	Scale of Survey.	By whom and when surveyed.	Remarks.
N.-W. Provinces.					₹	₹ a. p.			
Gorakhpur district .	8,558	4,808,320	4,596	0·59	7,71,650(*a*)	172 10 2	16″=1 mile	Major J. E. Sandeman, during seasons 1883—1888.	(*a*) Includes 5 square miles of Gorakhpur city surveyed on 24-inch scale, and 170 square miles of Forest Reserves on 8-inch scale, at ₹1,892 and 2,340 respectively. The mileage rate has been calculated on the cost of the cadastral portion only.
Basti „ .	7,615	5,260,420	2,816	0·34	6,36,025	225 13 9	Ditto	Lt.-Col. S. H. Cowan, during seasons 1883—1888.	
Central Provinces.									
Bilaspur district . .	2,237 (*b*)	3,735,993	3,179	0·54	4,35,260	136 14 8	Ditto	Lt.-Col. E. H. Steel and G. B. Scott, Esq., during seasons 1885—1889.	(*b*) *Khalsa* villages only.
Bengal.									
Sankarpur Estate . .	875 (*c*)	244,948	306	0·80	89,695	293 1 11	Ditto	Lt.-Cols. W. Barron and S. H. Cowan, during seasons 1886—1889.	(*c*) Villages much scattered, thereby adding greatly to the expenses of survey.
Maldwar „ . .	261 (*c*)	157,964	153	0·48	35,164	229 13 3	Ditto	Ditto ditto	
Angul „ . .	633	311,724	910	1·11	1,22,238(*d*)	181 6 9	Ditto	Ditto ditto	(*d*) Includes 120 square miles of Jungle Tracts and 251 square miles of Forest Reserves, at ₹6,058 and 18,934 respectively. The mileage rate has been calculated on the cost of the cadastral portion only.
Bánki „ . .	128	114,000	118	0·66	26,521	224 12 1	Ditto	Ditto ditto, during seasons 1887-88.	
Srinagar „ . .	605 (*c*)	543,772	613	0·73	120,825	197 1 8	Ditto	G. B. Scott, Esq., during seasons 1887—1889.	

Abstract of Out-turn and Cost of the Revenue Branch Parties according to Jurisdictions.

Province.	Scale of Survey.	Out-turn in square miles.	Cost.	Remarks.
			R	
North-Western Provinces	16 inches = 1 mile	1,203	1,08,592	(*a*) Traverse Survey, of which village skeleton plots on 16″ scale are furnished for survey of fields by *patwáris*.
	16 „ = 1 „	1,200(*a*)		
	8 „ = 1 „	83		
	4 „ = 1 „	159		
Bengal	50 feet = 1 inch	1	4,26,789	(*b*) Topography tested only on maps compiled from the Settlement Survey maps.
	16 inches = 1 mile	1,235		
	4 „ = 1 „	183		
	2 „ = 1 „	284		
Punjab	2 „ = 1 „	2,748(*b*)	64,975	
	2 „ = 1 „	698		
	1 „ = 1 „	70		
Assam	16 „ = 1 „	657	1,00,494	
Bombay	2 „ = 1 „	2,651	77,673	
Central Provinces	16 „ = 1 „	915	4,73,013	
	16 „ = 1 „	16,091(*a*)		
Burma	64 „ = 1 „	1	1,79,820	
	16 „ = 1 „	826		
	2 „ = 1 „	17		
Total	.....	29,022	14,31,356	

PART III.

THE OPERATIONS AT THE HEAD-QUARTERS OFFICES.

386. These Offices comprise—

(1) The Head-Quarters Offices at Calcutta.

(2) The Trigonometrical Branch Office at Dehra Dun.

During the absence on privilege leave of Colonel H. R. Thuillier, R.E., Colonel J. Sconce, S.C., officiated as Surveyor-General of India and Lieutenant-Colonel C. Strahan, R.E., as Deputy Surveyor-General in charge Revenue Branch, from the 11th April to 15th July 1889. Colonel D. Macdonald, S.C., resumed charge of the Surveyor-General's Head-Quarters Office on 22nd October 1888, but was subsequently transferred to the charge of a field party. Lieutenant-Colonel A. W. Baird, R.E., officiated as Assistant Surveyor-General from 10th January 1889, to 6th May 1889, when he was relieved by Lieutenant-Colonel M. W. Rogers, R.E., who was re-appointed Assistant Surveyor-General from that date. The charge of the Cartographic, Engraving and Map Record and Issue Offices remained in the hands of Lieutenant-Colonel C. Strahan, R.E., except for the short period while he officiated as Deputy Surveyor-General, Revenue Branch, when Colonel J. Waterhouse relieved him of the charge of the greater portion of the Drawing Office and Mr. T. Archdale Pope of the Map Record and Issue Office. The work of each of the Head-Quarters Offices is described below.

I.—HEAD-QUARTERS OFFICES, CALCUTTA.

SUPERINTENDENCE, CORRESPONDENCE, AND ACCOUNTS.

Personnel.

Colonel H. R. Thuillier, R.E., Surveyor-General of India.
Colonel J. Sconce, S.C., Deputy Surveyor-General, in charge Revenue Branch, Officiating Surveyor-General of India from 11th April 1889 to 15th July 1889.
Colonel D. Macdonald, S.C., Deputy Superintendent, 1st grade, Assistant Surveyor-General up to 9th January 1889.
Lieutenant-Colonel A. W. Baird, R.E., Deputy Superintendent, 3rd grade, Officiating Assistant Surveyor-General from 10th January 1889 to 6th May 1889.
Lieutenant-Colonel M. W. Rogers, R.E., Deputy Superintendent, 2nd grade, Assistant Surveyor-General from 7th May 1889.
Lieutenant G. B. Hodgson, S.C., Deputy Superintendent, 4th grade, Personal Assistant to the Surveyor-General up to 28th February 1889.
Mr. T. Archdale Pope, Officiating Deputy Superintendent, 4th grade, Personal Assistant to the Surveyor-General from 1st March to 1st May, 1889.
Mr. T. W. Babonau, Registrar.

Correspondence.

Mr. M. Francis, Head Clerk.
„ E. D. Algar, do.
„ J. A. Vallis, Senior Examiner.
„ T. E. Ware, Clerk.
Babu Kally Podo Banerjee, Clerk.
„ Banee Madhub Banerjee, do.
„ Doorga Narain Ghose, do.
„ Ram Kristo Chunder, do.
„ Chuni Lal Dey, do.
„ Bheecum Singh, do.
„ Gopal Chunder Dass, do.
„ Raj Coomar Dutt, do.
Mr. E. Bonnaud, do.
from 1st May 1889.
and 14 others.

Accounts.

Mr. H. H. Fenwick, Head Accountant.
Babu Bama Churn Chuckerbutty, Accountant.
„ Raj Krishna Mukerjee, do.
„ Hem Nath Dutt do.
and 5 others.

387. The Revenue Branch section of the office has been under the superintendence of Colonel J. Sconce, S.C., Deputy Surveyor-General, during the year, with the exception of the period when he officiated as Surveyor-General, during which time Lieutenant-Colonel C. Strahan, R.E., carried on the duties. The duties of the General and Topographical sections were superintended by Colonel D. Macdonald, S.C., up to the 9th January, when he was relieved by Lieutenant-Colonel A. W. Baird, R.E. On the transfer of the latter officer to the Calcutta Mint, Colonel M. W. Rogers, R.E., assumed charge. Lieutenant G. B. Hodg-

son, S.C., held the post of Personal Assistant up to the time of his proceeding on furlough, when he was succeeded by Mr. T. Archdale Pope.*

DRAWING OFFICE.

388. Lieutenant-Colonel C. Strahan, R.E., has been in charge of this office throughout the greater part of the year under report. For a period of four months, when Colonel Strahan's services were required for other duties, Colonel Waterhouse held charge in addition to his other duties. The principal work of the three sections into which the office is divided is reported on below, and a detailed statement of the work executed in each section is given in the appendix.

Personnel.

Lieutenant-Colonel C. Strahan, R.E., Assistant Surveyor-General, in charge.
Colonel J. Waterhouse, S.C., Assistant Surveyor-General, in charge from 10th April to 10th August 1889.
Mr. G. A. McGill, Chief Draftsman.
„ S. M. Smylie, Head Draftsman, from 24th November 1888.
„ P. J. W. Doran, Draftsman.
„ W. Green „
„ A. J. Musgrove „
„ J. R. Adels „
„ R. C. Sinclair „
„ A S. Bateman „
„ G. Gill „ up to end of February 1889.
„ A. J. J. Rodrigues, Draftsman, from 1st March 1889,
and two other draftsmen.

Native Draftsmen.

Munshi Nubi Buksh up to 13th June 1889.
Babu Harihur Sen.
„ Mohesh Chunder Shaw.
Munshi Muttiullah.
Babu Purna Chundra Sen.
„ Gopal Chunder Roy.
„ Tincowry Sen,
and 38 others.

Additional Establishment.

Mr. W. Stotesbury, Surveyor, 3rd grade, draftsman,
and 7 native draftsmen.

Surveyors and Assistant Surveyors on duty.

Mr. A. J. Wilson, Surveyor, 1st grade.
„ S. M. Smylie, Surveyor, 1st grade, up to 23rd November 1888.
„ E. S. P. Atkinson, Surveyor, 2nd grade, up to 29th August 1889.
„ F. Adams, Surveyor, 2nd grade.
„ W. C. Price, Surveyor, 3rd grade, from 1st March 1889.
„ A. J. James, Surveyor, 4th grade, from 1st August 1889.
„ H. T. Kitchen, Assistant Surveyor, 1st grade, from 26th November 1888.
„ S. O. Madras, Assistant Surveyor, 1st grade.
„ E. J. Martin, Assistant Surveyor, 1st grade.
„ C. G. S. Wood, Assistant Surveyor, 3rd grade, from 1st February 1889.

SECTION I.—GEOGRAPHICAL DRAWING AND COMPILATION.

389. In accordance with the scheme mentioned in paragraph 344 of the last Annual Report, that portion of the mapping of the North-West Trans-Frontier series which was previously undertaken in this office has during the year been transferred to the Trigonometrical Branch Office at Dehra, thus bringing the whole of the mapping of the country on and beyond our North-West frontier together in one drawing office. This has to a considerable extent lessened the strain on the Calcutta Office and has enabled it to make good progress with maps of Burma which are so urgently required. But during the year there has been so much work of an urgent nature which had to be at once taken in hand that there has again been considerable difficulty in carrying on the current departmental work, and many maps of an important nature have had to be put aside or have been considerably delayed in consequence.

390. The new compilation of Burma and adjoining countries, on the scale of 32 miles = 1 inch, which was commenced last year has been completed in outline and published in a preliminary form, and the office is now engaged on the completion of this map, which will contain the latest information and will also show the hill ranges. The map is well advanced and should be published early in 1890. The 16-mile preliminary map of Upper Burma, having been carefully revised and brought up to date, has been issued; and the approximate boundaries of divisions and districts have been inserted on it. The 8-mile series of maps of the Eastern Frontier is making steady progress. Sheet No. 1 of the S. E. Trans-Frontier has been published, and as it contains the latest information of the country lying between Chittagong and the Irrawaddy it will be a most

* The Assistant Surveyor-General reports as follows:—
"Mr. T. W. Babonau has ably carried on the management of the office. Messrs. Francis, Fenwick and J. A. Vallis, have also worked satisfactorily. The clerks generally have given satisfaction and the following deserve special mention:—Babus Banee Madhub Banerjee, Doorga Narain Ghose, Chuni Lal Dey, Bheecum Singh, Kanti Chunder Sen, and Raj Krishna Mukerjee."
The Deputy Surveyor-General reports that in the Revenue Branch Office Mr. E. D. Algar and Babu Kaly Podo Banerjee have rendered special good service, and that the other clerks have also worked well.

useful map to the coming Chin-Lushai expeditions. Sheets No. 8 of this series and No. 23 of the N. E. Trans-Frontier series have also been published. Several other sheets are well advanced and will probably be published early next year. Besides the above, several of the 4-mile sheets of Upper Burma have been revised and new editions published.

391. The 24-mile map of Afghanistan, the publication of which was deferred by the orders of the Foreign Department, has had several additions and changes made on it at the instance of the Quarter Master General's Department which have caused much re-drawing and will necessitate its being photo-zincographed again. Of the N. W. Trans-Frontier series, on the scale of 1 inch = 4 miles, four sheets have been completed and several others partially completed before they were transferred to the Dehra office.

392. The 32-mile map of India has been revised and published as a second edition, and the drawing of a third edition, to contain Baluchistan and part of Afghanistan from latest materials, has been completed. The 48-mile map of India, known as the skeleton railway map, has passed through a second edition: it has been extended so as to include the whole of Baluchistan and Burma. This map is also published on the 64-mile scale, which has been obtained by photographic reduction from the same original.

393. In addition to the usual current departmental work, a large amount of miscellaneous work has been done, including many administration report and statistical maps; but it is much to be regretted that owing to the calls for maps of Burma and other urgent work, the publication of maps of divisions and districts has fallen much in arrears. In fact, the regular departmental work is now gradually being forced to give way to urgent demands from other departments and offices. The work of the Drawing Office has increased enormously in the last ten years, while the staff of draftsmen to cope with it has remained the same. Arrears are thus steadily accumulating and it points to the necessity of increasing the establishment of draftsmen, otherwise the efficiency of the office to meet all demands cannot be maintained.

394. The examination of fair maps sent in by the field parties of the Topographical Branch, before passing them on for reproduction, has been carried on as usual.

SECTION II.—REVENUE.

395. Besides the regular work of examining and preparing for photozincography the fair maps received from the field parties of the Revenue Branch, of correcting to date and republishing old maps, of supplying data, &c., this section has been employed in drawing the fair topographical maps of the Gorakhpur and Mirzapur districts on the 2-inch scale, by reduction from the cadastral sheets on the 16-inch scale, and also in completing the fair topographical maps of the Basti district. The map of Benares city to which reference was made in para. 350 of the Annual Report for last year has been drawn on the 16-inch scale for reduction to the 8-inch and 6-inch scales and sent to press. In addition to the above work the map of the city of Calcutta, on the scale of 200 feet to an inch, in 15 sheets, has been commenced and 13 of these sheets have been projected and plotted.

396. The $\frac{1}{8}$-inch district maps of the North-West Provinces, the preparation of which was transferred to this department last year from the mapping office of the Board of Revenue at Allahabad, have made good progress. Out of the eleven district maps to be drawn, those of Hamirpur and Agra have been published, Jaunpur and Bijnor are under publication, and Ballia, Benares and Ghazipur are in an advanced state of preparation. Considerable delay in the publication of these maps is caused by the corrections that are made on the proof prints when sent to the District officers, notwithstanding the circumstance that copies of the 1-inch standard sheets are sent in the first instance, for the purpose of the necessary corrections being inserted thereon before the drawing of the district map is commenced.

397. The small computing section attached to this office has again had an unusual amount of extra work thrown on it, and it was with the greatest difficulty that the final examination of the computations and records of the Gorakhpur survey, which extended over five years, was completed.

SECTION III.—CADASTRAL.

398. This section is employed in preparing the original maps of all the Cadastral Surveys for zincography and photo-zincography. The method is to examine the numbering of the fields and to observe if all holdings and divisions have been correctly entered and referred to in the several area statements. The total number of maps passed for publication during the year was 3,692, of which 868 were zincographed, and 2,824 were photo-zincographed, showing a decrease of 174 on the return for last year. Of printed maps, 3,134 were coloured and in due course examined and sent for record with the Settlement officers of the districts to which the maps belonged.

The maps finally completed and published have been arranged and bound into 82 volumes for record in this office, and 40 volumes of printed cadastral maps of districts in Lower Burma have also been arranged in circles and townships, indexed, examined and bound, and sent to the Chief Commissioner of Burma.

399. The demand for printed copies of cadastral maps in the North-West Provinces is still increasing, as is apparent by the call for reprints, the increase in this respect being about 366 over last year. As usual, extra copies of village maps of districts Basti and Gorakhpur have been struck off for sale to the public from the depôts in these districts.*

ENGRAVING OFFICE.

400. The superintendence of this office was carried out in conjunction with that of the Drawing Office by Lieutenant-Colonel C. Strahan, R.E., and Colonel J. Waterhouse at different periods. The supervision of the engravers remained in the hands of Mr. G. G. Palmer throughout the year.

Personnel.

Lieutenant-Colonel C. Strahan, R.E., Assistant Surveyor-General, in charge.
Colonel J. Waterhouse, S. C., Assistant Surveyor-General, in charge from 10th April to 10th August 1889.
Mr. G. G. Palmer, Superintendent.
„ W. Donaldson, Engraver.
„ D. L. Mitchell „ on furlough.
„ J. Fulford „
„ T. B. Roger „
„ S. M. Coard „
„ A. W. N. James „
„ A. R. Coard „
„ E. C. Ollenbach „
„ E. Earle „
„ L. H. Musgrove „
„ F. R. C. Scallan „
23 Native Engravers.
3 Apprentices.

Copper-plate Printing Section.

Mr W. T. Collins, Copper-plate printer.
„ A. E. Pilley, Assistant Copper-plate Printer and Store-keeper.

Mr. Mitchell has been obliged to extend his sick-leave throughout the year, owing to continued ill-health, and the loss of his services has been much felt.

401. The out-turn of work is much the same as during last year. There has been a slight falling off in the number of letters cut, which is more than compensated for by an excess of 1,463 square inches of outline cut above last year's amount. The number of impressions pulled in the copper-plate printing is slightly less than that of last year, owing to one of the presses with three men having been transferred to the Photographic Office towards the end of the year to carry on the printing of the heliogravure plates.

402. The 32-mile map of India in outline, which is being prepared by obtaining matrices from the original plates by the electrotype process and then removing the hills, has made good progress; all the plates, except No. 3, have been repaired where the names and outline were unavoidably destroyed in the process of erasing the hills. Plate 3 has yet to have the hills removed from the matrix, and several small portions have to be filled up when this plate is electrotyped.

A duplicate plate of sheet No. 1. of the 64-mile map of India has been taken by the electrotype process; all names that were erroneously spelt in the original have been erased from the matrix and correctly cut on the duplicate plates.

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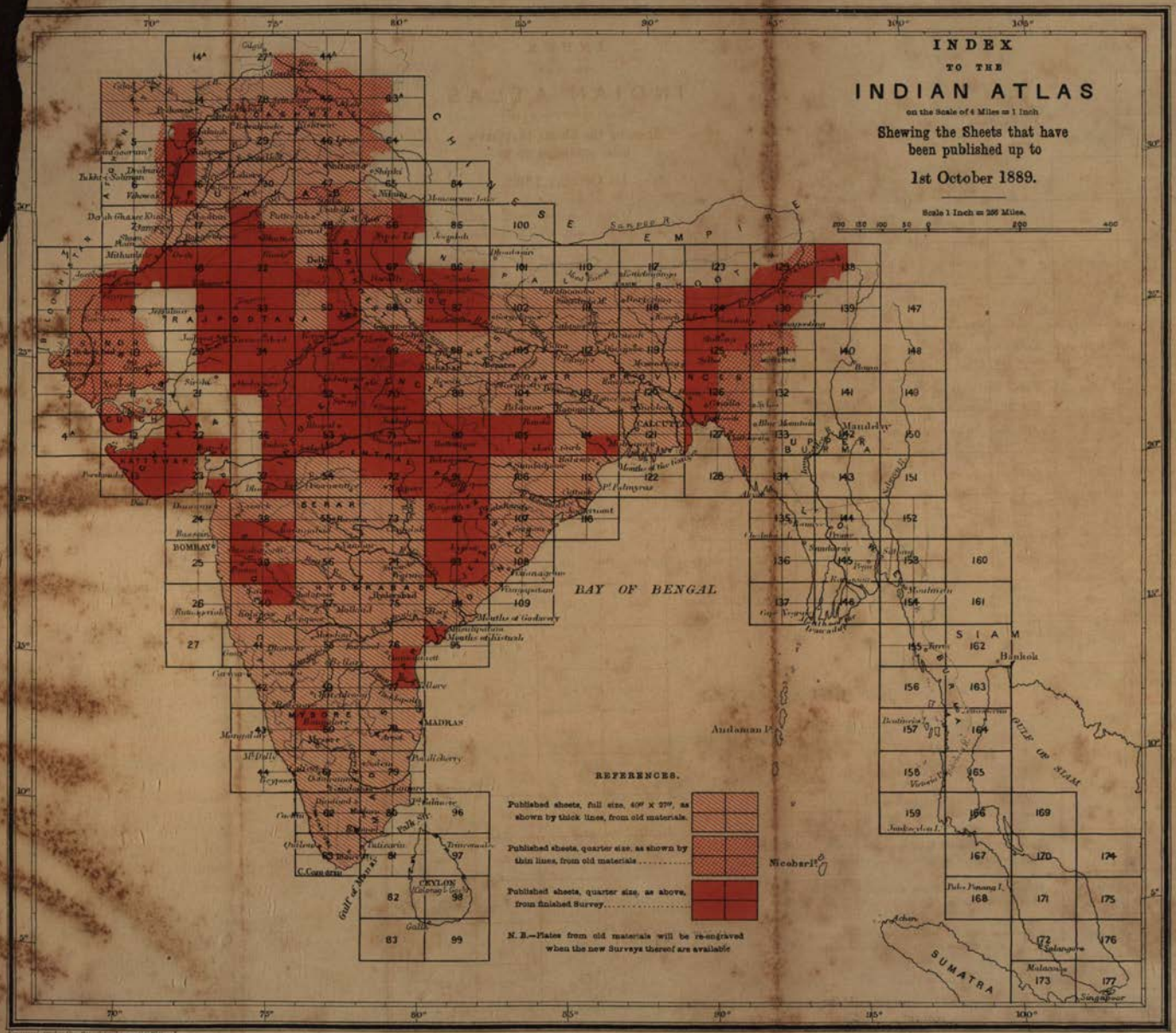
* Lieutenant-Colonel Strahan reports well of the way in which Messrs. McGill, Smylie and Stotesbury have supervised the three different sections, more especially the way in which Mr. Smylie has fulfilled his duties. Mr. Adams and nearly all the European and Native draftsmen have done good work; the following are specially worthy of mention:—Messrs. Green, Musgrove, Sinclair, Rodrigues and Native draftsmen Harihur Sen, Mohesh Chunder Shaw, Muttiullah, Purna Chunder Sen, Gopal Chunder Roy, Tincouri Sen, Abdul Razzack and Abdul Aziz.



Reg. No. 2096, S. I. D.—28-12-89.—350.

Litho., S. I. O., Calcutta.

INDEX
TO THE
INDIAN ATLAS
on the Scale of 4 Miles = 1 Inch
Shewing Work in hand on the
1st October 1889.
Scale 1 Inch = 256 Miles.
200 150 100 50 0 200 400
RAJPOOTANA
SINDH
BERAR
HYDERABAD
MYSORE
MADRAS
BOMBAY
CENTRAL PROVINCES
NORTH WESTERN PROVINCES
CALCUTTA
Mandalay
UPPER BURMA
SIAM
Bankok
BAY OF BENGAL
Andaman Is.
Nicobar Is.
CEYLON
Gulf of Manar
GULF OF SIAM
SUMATRA
Singapoor
Malacca
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Cape Negrais
Table I.
Diu I.
Ferozabad
Mouths of the Godavery
Mouths of the Cauvery
Mouths of the Kistnah
Pt. Calimere
Pt. Palmyras
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Table I.
Cape Negrais
Sandoway
Akyab
Mouths of the Ganges
Mouths of the Godav

The 16-mile map of the North-West Provinces and Oudh in 2 sheets is well advanced, having been completed in outline as far as reliable material is available, and the writing almost completed on one plate. The 16-mile map of the Punjab in 4 sheets is also well advanced, one plate being completed in outline and writing, while two others are almost completed, leaving only one plate to be put in hand for writing.

403. During the year a large number of miscellaneous maps were commenced, amongst which are 32 district maps on scales varying from 8 to 16 miles to an inch: owing to the constantly recurring demands for these maps, it has been thought advisable to engrave them on copper: good progress has been made in this work. Full details of the work performed in this office will be found in the appendix.*

PHOTOGRAPHIC AND LITHOGRAPHIC OFFICE.

Personnel.

Colonel J. Waterhouse, Assistant Surveyor-General in charge.
Mr. T. A. Pope, Officiating Deputy Superintendent, 4th grade.

NEGATIVE SECTION.

Normal Establishment.

Mr. H. Haward, Head Assistant in charge.
Mr. G. G. Dempster, Photographer.
Ismail Khan, Asst. Photographer.
Mr. G. W. Mackie, Assistant Photographer.
Mr. E. Savedra, apprentice.
Two negative retouchers.

Cadastral Establishment.

Mr. C. Marshall, Photographer.
,, L. Lagnier, ditto.
,, T. Lloyd, Offg. ditto.
,, C. DeCruze, Assistant Photographer, three assistant photographers and three negative retouchers.

PHOTO-TRANSFER PRINTING SECTION.

Normal Establishment.

Mr. J. Harrold, Photographer.
Habbibul Hossain, Assistant Photographer.
Mr. P. C. Michael, apprentice.

Cadastral Establishment.

Mr. R. George, Photographer, and two assistant photographers.

SILVER-PRINTING SECTION.

Normal Establishment.

Mr. C. J. Meade, apprentice, and one assistant photographer.

HELIOGRAVURE AND COLLOTYPE SECTION.

Mr. A. W. Turner, Photo-Engraver.
Mr. P. Mackenzie, apprentice, two engravers and three copper-plate printers.
Mr. J. T. Meade, Collotype Printer.

LITHOGRAPHIC DRAWING SECTION.

Mr. H. L. Lepage, Head Assistant.
Babu Ambica Churn Mookerjee, Examiner.
Moonshi Sobhan Bux and 24 others, Draftsmen.
Mr. E. Dowling, apprentice.

ZINC-PRINTING SECTION.

Normal Establishment.

Mr. B. Mackenzie, on furlough.
,, E. A. Le Franc, Zincographer.
,, F. R. Vandyke, Officiating Zincographer.
Mr. J. B. Mackenzie, Assistant Zincographer, one writer, and four zinc correctors.

Cadastral Establishment.

Mr. J. Watson, Zincographer.
,, G. A. Le Franc, apprentice, one writer and nine zinc correctors.

LITHO-PRINTING SECTION.

Mr. D. Deas, Head Lithographic Printer.
Mr. S. U. Ravenscroft, Assistant Lithographic Printer.

TYPE-PRINTING SECTION.

Mr. E. DePyvah, Head Type Printer.

CORRESPONDENCE AND ACCOUNTS SECTION.

Normal Establishment.

Mr. W. Moore, Store-keeper.
Babu Kanny Lall Sen, Clerk and Accountant.
Babu Gopal Chunder Mookerjee, Clerk, and one other.

Cadastral Establishment.

One Clerk.

LITHOGRAPHIC ESTABLISHMENT.

Babu Russick Lall Shaw, Clerk, and five others.

404. As the Photographic and Lithographic Offices have, during the year, been brought under one roof in the new building, it seems desirable to treat them together, pending arrangements for the amalgamation of the establishments which are under consideration.

405. Colonel J. Waterhouse, S.C., was in charge of the offices up to the 9th September 1889, when he went on privilege leave and made over charge to Mr. T. A. Pope, who officiated for him for the remainder of the year under review. Mr. Pope also took charge of the current duties of the office during Colonel Waterhouse's absence on deputation to Dehra Dun, from October 23rd till the 13th November 1888.

406. There have been but few changes in the establishment of the offices during the year. Mr. B. Mackenzie, the head zincographer, was on furlough all the year, and, in order to meet the increasing work in the zinc-printing section of the Photographic Office, as well as to provide a successor to Mr. Watson on his approaching retirement who would be competent to take charge of the new machinery, the services of 2nd Corporal F. Vandyke, R.E., of the Queen's Own Sappers and Miners, were

* Mr. Palmer has supervised the Engraving Office most satisfactorily, and the European engravers have all done good work; the apprentices now take their full share of finished work. The Native engravers are also on the whole well reported on.

obtained from the Military authorities. He joined the office from Bangalore on the 2nd August 1889, and Colonel Waterhouse reports that he has worked well and seems likely to suit.

407. The term of five years' agreement of several of the apprentices in both offices expired on the 31st July, but, with the sanction of Government, their services have been retained for a time on the same pay as they were drawing during the last year of their apprenticeship. It is hoped that during the year permanent employment may be found for them.

408. The general abstract of the work turned out in both offices is given below: and though on the whole the out-turn, in some respects, is somewhat under that of last year, it is well up to the average. It must be taken into consideration that the removal of the offices during the year necessarily caused some interference with the work, though less than might have been expected.

General Abstract of Work done during 1888-89.

Specification of Plate or Print.	Sheets or Subjects.	Negatives and transparencies.	Photo-zincographic and Lithographic Printing.								Type Printing.			Silver and other Printing.		Heliogravure and Electro-typing.			Photo-collo-type.		Value.
			Photo-transfer Prints.	Zinc Plates transferred.	Zinc Plates printed.	Stones.	Pulls.	Number of Copies.			Pages or items.	Pulls.	Copies.	Silver Prints.	Blue Prints.	Plates photo-etched.	Heliogravure Prints.	Electro-types.	Plates.	Prints.	
								Colored.	Uncolored.	Total.											
																					R a. p.
Departmental maps and plans	959	1,264	994	337	309	129	117,725	3,070	106,391	109,461	...	...	...	155	1,047	16	490	9	1	...	45,012 13 9
Cadastral maps	3,587	2,819	2,821	3,642	3,642	...	103,882	...	96,290	96,290	...	...	...	...	...	...	...	...	...	...	52,529 12 3
Extra-departmental maps and plans	994	713	698	370	334	358	348,357	50,863	388,997	439,860	...	...	...	234	49	34	19,817	3	3	826	54,553 2 3
Work done in Type-printing Section	...	...	...	...	...	...	...	...	...	...	6,646	1,177,175	534,257	...	...	...	...	...	...	...	17,505 13 0
Total	5,540	4,796	4,513	4,349	4,285	447	579,964	53,933	591,678	645,611	6,646	1,177,175	534,257	389	1,096	50	20,307	12	4	826	1,69,505 9 3

409. In the Lithographic Office, although the out-turn of the litho. presses has been somewhat less than last year, principally owing to a falling off in the demands for lithographed departmental forms and for weather charts for the Meteorological Departments, which are printed in the small litho. machine, the amount of work in hand generally has been greater, and the drawing and printing sections have been quite as fully occupied as during the preceding year.

The total number of subjects taken in hand and mostly printed off was 803, or 87 more than last year, though the number of copies and press pulls was less, being 368,673 and 342,820, against 410,391 and 392,554 of last year respectively. This indicates that the demand for work has been greater, but a smaller number of copies has been printed off. As usual, the bulk of the work done in the Drawing and Litho-printing sections has been for other departments and again shows an increase, the number of originals received being 643, of which 308,745 complete copies were printed with 278,492 pulls. The value of the work done was R26,780-10-6. Last year the number of originals was 539, and of complete copies 279,837 with 259,322 pulls, the value being R27,296-5-6.

The departmental work in these sections, on the other hand, shows a very considerable decline, only 160 subjects having been received, of which 64,328 pulls and 59,928 complete copies were printed, against 177 subjects, 133,232 pulls and 130,554 complete copies of last year.

410. In the Photographic Office there has been a heavy pressure of work throughout the year, and an increase is shown in the printed out-turn, both of departmental and extra-departmental work, the number of original subjects being 1,150 with 123,262 pulls and 180,648 complete copies. Of these subjects 799 were departmental and 351 extra-departmental; the former showing an in-

crease of 171 over, and the latter a decrease of 491 under, last year. The relative out-turn of printing is 53,397 pulls departmental, and 69,865 extra-departmental, against 51,665 and 64,127 of last year respectively; and of complete copies 49,533 departmental, and 131,115 extra-departmental, against 50,871 and 91,122 of last year respectively.

The number of cadastral maps reproduced again shows a falling off, the number of sheets printed being 3,642 with 103,882 pulls and 96,290 complete copies against 3,897 sheets with 121,921 pulls and 114,733 complete copies of last year.

411. The work of the Type-Printing section has further increased in quantity. Many of the forms hitherto printed from stone have been set up in type and printed in the machine with considerable economy of cost and time. The number of items or pages set up was 6,646, with 1,177,175 pulls and 534,257 complete copies, against 5,375 items, with 986,666 pulls and 497,289 complete copies, of the previous year.

412. The publications are detailed in the statements given in the appendix, and among the departmental maps the following are worthy of notice:—

The second edition of the 32-mile map of India, in six sheets, was completed and published during the year: it will, however, be necessary to prepare a third edition of this map immediately, showing extensions of territory, east and west. The 24-mile map of Afghanistan, in two colours, has also been under preparation a second time by photo-zincography during the year: proofs were prepared for approval, but, owing to the large number of corrections received from the Quarter Master General's Department, it had to be re-done and is now nearly ready. A map of Burma and Adjacent Countries, in outline, on the 32-mile scale, has been printed off, preparatory to the issue of a complete map with hills, which is now nearly ready. New editions of the Skeleton Railway Map of India, on the scales of 48 and 64 miles to the inch, have also been under preparation. A fifth edition of the preliminary map of Upper Burma, with extensive corrections and additions, was photo-zincographed and printed.

Provincial maps of Assam, corrected to November 1888, and of the Lower Provinces of Bengal, on the scale of 16 miles=1 inch, with corrections to January 1889, have been transferred to stone from the engraved copper-plates and published. Among the plans of cities and cantonments photo-zincographed, the principal are Baroda city, Deesa cantonment, Mandalay city and a new edition of the Simla Guide-map. A plan of the city and cantonment and environs of Benares was commenced and will be completed during the current year.

413. In the Lithographic Office, six standard 1-inch sheets of the Oudh Revenue Survey, districts Unao, Kheri and Fyzabad, and three sheets of Mymensing were drawn, while four sheets of Oudh, districts Kheri, Hardoi, Bahraich and Gonda, and one of Mymensing were printed.

414. In the Photographic Office, 272 standard sheets were in hand, but of these only 131 were printed off and published during the year. These include one sheet of the Bengal Survey, district Cuttack; 5 sheets of the Lower Burma Survey, on the scale of 1 inch=1 mile, districts Bassein, Hanthawaddy, Tharrawaddy and Pegu; 12 sheets on the scale of 4 inches=1 mile, districts Tharrawaddy, Prome and Toungoo; also a preliminary edition of one sheet on the scale of 1 inch=8 miles. Of the Upper Burma maps (South-Eastern Frontier Series), 15 sheets have been printed on the scale of 1 inch=4 miles, chiefly new editions; of the North-Eastern Frontier Series, 2 sheets have been published on the scale of 1 inch =4 miles, and three sheets on the scale of 1 inch=8 miles.

415. The miscellaneous maps include maps of the Chin Hills, of part of Karenni and of part of the Bhamo district, all on the scale of 1 inch=4 miles. Eight district maps on the 4-mile scale, which had been previously transferred to stone from the copper-plates, were completed and printed, *viz.*, Durbhanga, Chanda, Mozufferpore, Sarun, Chumparun, Sibsagar, Hazaribagh, and Ghazipur districts; Rungpur and Monghyr were prepared, but have not yet been printed. A very large number of maps of Bengal, on the scale of 1 inch=80 miles, were prepared and printed in colours for the Administration Report of the Government of Bengal, to illustrate Education, Revenue, Excise, Emigration, Income-Tax, Police, Telegraph and Postal Lines, Litigation, Meteorology, Soils, Cholera, Fever, Small-pox, Vaccination and Prices of Rice and Wheat. The new arrangement for printing at one time the full number of copies of these maps required for illustrating the provincial departmental reports, as well as for the Government of Bengal

Administrative Report, has been found to work well; and as the maps are done at intervals throughout the year, the heavy pressure required for producing all the maps at once is avoided, and the same maps are not prepared and printed twice in the year, as was formerly not unfrequently the case. Similar maps, illustrating Excise operations, have been prepared and printed for the Punjab Government. A large number of Index maps, several technical charts and miscellaneous subjects have been printed for departmental use and issue to the public. Among the latter may be mentioned a reproduction of the printed Tide-Tables for the ports of Bombay, Rangoon and Kurrachee, the supply of which had run short: they were copied by photo-zincography very quickly and with absolute accuracy.

416. Among the large number of maps, &c., done for other departments in both offices, the following may be specially noted:—A chart, showing the telegraph lines in operation, on the scale of 1 inch=32 miles, in six sheets, drawn for the Telegraph Department, but not yet printed; two Railway maps of India on the scale of 1 inch=96 miles, showing gauges and systems, prepared and printed for the Director General of Railways. More of the series of military maps of country 10 miles round various cantonments have been lithographed or photo-zincographed for the Quarter Master General's Department, among them Belgaum and Jullunder, printed off; Jhelum drawn and printed; Meerut and Rawal Pindi drawn but not printed; country 20 miles round Jaulna and 10 miles round Gurgaon and Delhi photo-zincographed; also a map of communication in the Peshawar district, scale 1 inch=4 miles, was drawn and printed, and two maps of communications in the Bundelkund district, in two sheets, scale 1 inch=8 miles, was drawn but not printed, and a similar map of the Presidency district in 15 sheets, scale 1 inch= 1 mile, was commenced and some of the sheets completed.

For the Public Works Department, a large number of plates, illustrating water-works in India, have been printed.

Maps of the districts of Banda and Hamirpur, on the scale of 1 inch=2 miles, have been photo-zincographed and printed off for the Board of Revenue, North-Western Provinces, in continuation of the series of these maps which are being prepared for the Board in the Drawing Office of this department.

For the Revenue and Agricultural Department of the Government of India, 5 plates illustrative of Economic Entomology and 5 plates of the Technical Art Series, have been reproduced in heliogravure. Other subjects reproduced in this manner are noticed below.

417. The Military and Railway map of India, of which the proximate completion was announced in last year's report, was completed early in the year; but owing to changes in the Military Commands, and also to the requirement of showing more country to the east and west, it no longer answers the purpose for which it was prepared, and is at present in abeyance. This is much to be regretted, because the map is otherwise a good one, and a great amount of labour has been expended on it solely for military requirements. It is to be hoped that some way of utilising it may be found.

418. In the Photographic Office there have been few or no changes of methods during the year. Cyanotype printing has almost entirely superseded silver printing for producing the reduced prints of standard maps required for the use of the engravers and for most other departmental purposes. Collotype printing has not been much used, but is sometimes found convenient and suitable for special work. The photo-etching process of heliogravure has made good progress during the year; 53 plates have been prepared and very nearly 28,000 copies have been printed. Among the principal subjects may be noted—a portrait of Her Excellency the Countess of Dufferin, for the Annual Report of the Countess of Dufferin's Fund; also a portrait of H. E. the Marquis of Dufferin and Ava; 16 plates illustrating Dr. Führer's Report on the Sharqi architecture of Jaunpur; one plate of sheets 7 and 8 of the Andaman Survey reduced one-half from the original sheets, five plates illustrating Economic Entomology, for the "Indian Museum Notes," reproduced from the original pencil drawings, and a Weather Chart for Bombay. Two specimens of brush-shading with the air-brush were reproduced, as an experiment, for the Director of the Ordnance Survey, and succeeded fairly well.

419. The work of electrotyping has been carried on more or less during the year, and seven plates have been electrotyped for the Engraving Office. The process is found most useful for duplicating new maps of provinces, &c., in their different stages.

420. The most important event of the year has been the removal of these offices into the new building, No. 14, Wood Street. Colonel Waterhouse has given a full description of the buildings in the appendix, and the accompanying plans and heliogravure plates will give a good idea of the arrangements and of the external and internal appearance of the building. It will suffice, therefore, to say that they were designed by Mr. W. B. Gwyther on the basis of plans furnished by Colonel Waterhouse, and are arranged in a square block on the four sides of a central quadrangle, the northern half being for the most part devoted to the accommodation of the Lithographic and Zincographic Printing sections, while the Photographic sections occupy the southern half.

The principal feature of the building is the large press-room, 62 feet wide and 118 feet long, with a gallery 16 feet wide all round. On the ground-floor the whole of the lithographic draftsmen, presses, type and type-presses, and the lithographic and type-printing machines are accommodated, while the gallery takes all the zincographic presses and zinc-correctors. The whole of the presses being thus in one room instead of being scattered between three houses, as heretofore, very greatly increases their working power. The cadastral presses, which, owing to the falling off in cadastral work, had not been fully occupied lately, can now very conveniently be utilised in meeting the heavy pressure on the Lithographic and normal Zinc-printing sections. The establishment can also more easily be kept under observation and proper supervision. The room is well lighted and ventilated, and it is hoped that even in hot weather it may not be too oppressive.

On the Photographic side, the principal glass-house is much larger and better lighted than the old one, and the dark-rooms are more commodious. An additional glass-house facing the north has been added and is useful for miscellaneous work other than copying maps drawn in pen and ink; a suitable laboratory and dark room for experimental purposes have been provided for the officer in charge. In the old accommodation this requirement was very unsuitable.

The accommodation for the Heliogravure, Collotype and Silver-Printing sections has been greatly improved. Ample water-supply has been laid on all over the building, and gas has also been laid on in some of the photographic rooms for heating and drying purposes, which is found a very great convenience. The floors throughout the building are of Garlick's patent stone, which enables all matting to be dispensed with, and the rooms can be easily kept clean and free from dust. A commodious stone-godown has been provided for properly housing the large supply of lithographic stones, which formerly had little or no proper protection from damp and weather. Two ranges of masonry settling-tanks have been built outside the negative and silver-printing dark-rooms to catch all the waste washing-waters containing silver, in order to recover the metal from them. Good, dry store-rooms have also been provided, and suitable fittings and fixtures have been supplied in all the work-rooms.

421. Colonel G. F. S. Neill, the Superintendent of Works, and the officers of the Public Works Department connected with the building, have all done their best to carry out the requirements of such specially technical offices, and it is very gratifying to be able to report that the improved accommodation, so long needed by these important offices, has at last been provided, and that the whole arrangements are found to answer admirably. The concentration of the whole establishment in one building has been found, as was anticipated, a very great advantage; it greatly increases the working power and lessens the difficulties of superintending so many different kinds of work.

422. The removal of the offices began in June 1889 with the Heliogravure, Collotype and Cadastral Zinc-printing sections from No. 2, Wood Street, which was given up on the 15th June. During July, the Lithographic Office was removed from No. 1, Camac Street, and that house given up on the 1st August. The remaining sections of the Photographic Office, with the exception of the Negative section, were moved in August, and the removal of the whole was completed before the end of September. Arrangements were made for carrying on the work during the removal, and there was little or no entire stoppage in any section.

423. The new machinery for steam litho-printing had not all arrived at the end of the year under review.

Further details of the operations of the year are given in Colonel Waterhouse's report, which will be found in the appendix.*

MAP RECORD AND ISSUE OFFICE.

424. Lieutenant-Colonel C. Strahan, R.E., held charge of this office for eight months of the year under report; during the remaining four months, Mr. T. A. Pope carried on the duties.

Personnel.

Lieutenant-Colonel C. Strahan, R.E., Assistant Surveyor-General, in charge.
T. A. Pope, Esq., Officiating Deputy Superintendent, 4th grade, in charge from 10th April to 10th August 1889.
Mr. A. E. Byrn, Head Assistant.
„ H. R. Vallis, Map Curator, and 12 clerks.
„ B. M. Wilson, Assistant Surveyor, 2nd grade, attached.

425. During the year under report the number and value of maps issued were as follows:—

Maps issue	Number.	Value.
		₹
General maps to Government officials	64,432	38,307
Ditto to India Office, London	1,597	1,928
Ditto to Agents	2,323	3,294
Ditto to private individuals on cash sale	7,029	8,318
Total	75,381	51,847
Cadastral maps to Government officials	92,146	53,997
GRAND TOTAL	1,67,527	1,05,844

426. There is a slight increase in the number of general maps issued to Government officials during the year, though their value is somewhat less as compared with last year's totals, probably owing to the larger demands made for small maps to illustrate Administration Reports, the cost of which is small. There is a decrease in the number of cadastral maps issued during the year, owing to the village maps of the cadastral surveys in the Central Provinces and Bengal not being required to be printed.

427. During the past year, the actual cash sales amounted to ₹9,424, *viz.*, ₹8,318 received from private individuals, and ₹1,106 from map sale agents, and in the Revenue section 623 applications were received for extracts from original records of Revenue Surveys, chiefly from private individuals for the settlement in civil courts of boundary disputes, and 2,648 copies of village plans were supplied at a cost of ₹5,489.

428. The following statement shows the details of work done:—

Details.	Number.
Applications received for maps	3,435
Letters issued in reply	2,107
Cash and credit map sale bills	1,191
Invoices and receipts issued for published maps	1,777
Ditto ditto for cadastral maps	190
Ditto ditto for extracts from original records	214
Packets, parcels, and local despatches	3,976
Ditto received in the office	700
Packages despatched by rail and steamer	361
Ditto received by ditto	59
Maps colored for sale and issue	20,968
Ditto for other departments	2,217

* Colonel Waterhouse again records his satisfaction with the way in which the European and native assistants of the Photographic and Lithographic Offices have carried on their duties during the year. In the Lithographic Office, Mr. Lepage, the Head Assistant, Mr. Deas, the Head Printer, and Mr. DePyvah, in charge of the Type section, carried out the removal of the presses, &c., with excellent judgment and care. Among the draftsmen, Babu Umbica Churn Mookerjee, Dinonath Dass, and Munshis Abdul Hamid, Abdul Mujid, and Mahomed Yassin, deserve special mention. Mr. Dowling, the apprentice, has made excellent progress, and the clerks have all worked well.

In the Photographic Office, Messrs. Haward, Turner, Harrold, Marshall, Watson, and Le Franc, together with Mr. Moore, Store-keeper, and Babu Kanny Lal Sen, Head Clerk and Accountant, have satisfactorily superintended the working of their several sections and their removal and setting up again in the new offices. The subordinate assistants in the various sections have all worked well.

429. The new catalogue of maps published by the department has been completed. It has been prepared by Provinces, and with the exception of Burma, all the parts have either been published or are passing through the press. The catalogue of Burma maps is being held in abeyance until the surveys are more advanced and a sufficient number of maps exists to render a catalogue necessary.

A list of maps published during the year is given at page 97.*

MATHEMATICAL INSTRUMENT OFFICE.

430. During the period under report, the charge of the Mathematical Instrument Office has been held by three officers. Colonel Macdonald, Assistant Surveyor-General, was in charge up to the 9th January 1889, after which Lieutenant-Colonel A. W. Baird, R.E., Officiating Assistant Surveyor-General, held charge until the 6th May, when he was succeeded by Lieutenant-Colonel M. W. Rogers, R.E., Assistant Surveyor-General.

Personnel.

Colonel D. Macdonald, B.S.C., Deputy Superintendent, 1st grade, Assistant Surveyor-General, in charge up to 9th January 1889.
Lieutenant-Colonel A. W. Baird, R.E., Deputy Superintendent, 3rd grade, Officiating Assistant Surveyor-General, in charge from 9th January to 6th May 1889.
Lieutenant-Colonel M. W. Rogers, R.E., Deputy Superintendent, 2nd grade, Assistant Surveyor-General, in charge from 6th May 1889.

Workshop Branch.

Mr F. Marshall, Officiating Mathematical Instrument Maker.
„ T. R. Theakston, Assistant Mathematical Instrument Maker.
64 Permanent artificers to November 1888, and 58 from December 1888.
150 Artificers on an average, on temporary establishment.
3 Eurasian apprentices.

Store Branch.

Mr. W. Campagnac, Instrument Store-keeper.
Babu W. C. Chowdry, Material ditto.
1 Packing Sircar and 2 packers.

Office Establishment.

Mr. C. O. Gray, Head Clerk,
„ M. C. Belletty, 2nd Clerk,
and 6 other permanent clerks.

431. The figures given in this report refer to the Financial year 1888-89, *i. e.*, from the 1st April 1888 to 31st March 1889. During this period 37,806 serviceable instruments, valued at ₹2,48,061, were received into store and 36,500 instruments, valued at ₹2,07,621, were issued. The value of the stock of serviceable instruments was therefore increased by ₹40,440.

432. The following tabular statement shows the principal sources from which the serviceable instruments were received :—

Source of Receipt.	Number.	Value.
		₹
From England on indent	9,611	1,12,093
By purchase in local market	9,612	35,615
Manufactured in workshop	11,220	33,082
Returned to store by public officers	1,682	13,343
From other manufacturing offices	2,003	195
From repairable stock after repair	3,551	53,182
From other sources	127	550
Grand Total	37,806	2,48,060

433. The value of the instruments obtained from England as compared with the figures of the previous year shows a slight diminution, whilst the number of instruments has increased; this is due to the fact that a larger number of instruments of small value, such as instrument boxes and pins for maps, was

* Amongst the assistants in this office Mr. H. R. Vallis deserves special mention for the way he has performed his duties as Map Curator; Mr. G. Belletty, a clerk under him, has also worked well.

obtained, whilst there were fewer costly instruments obtained, notably as regards theodolites, of which 40 less were received. The reverse of this is the case in the second item, *viz.*, purchases in the local market, the value of which was almost identically the same as last year, whilst the number was not much over one-fourth: this is due to about 20,000 pins for chains and maps having been purchased last year, each of which in departmental nomenclature is a separate instrument.

There is a considerable falling off in the number and value of instruments repaired for store and issue; this is due to the fact that for some time after moving into the new office, the steam machinery was not ready, and as the current repairs for public officers had to be kept up as usual, the loss in the amount of work done fell on the item of making serviceable the repairable stock.

434. During the year the office received 5,442 repairable instruments, valued at ₹54,387. The total issues from repairable stock amounted to 3,689, valued at ₹34,599; of these, 3,547 instruments, valued at ₹34,215, were repaired at a cost of ₹18,966 and transferred at the enhanced value to the serviceable stock. The repairable stock has thus been increased in value during the year by ₹19,788.

This increase, although partly due to the diminished out-turn of work as mentioned above, and to the larger amount of instruments returned by public officers, is also attributable to the increased amount of work on current repairs. The establishment of workmen has twice been increased with a view of coping with the accumulation of repairable instruments, but the increase in the demands for current repairs by public officers (which has always been considered to have the first claim on the workshops) has so increased of late years, that the men engaged on these extra grants have gradually been employed on outside repairs. The first grant of ₹300 per mensem has been made permanent, whilst the second grant of ₹150 per mensem expires in November next, but its permanent renewal is absolutely necessary to enable this office to meet the ever-increasing demands made upon it.

435. In February 1889 a committee of departmental officers was appointed by the Surveyor-General to examine and report on a large number of old-fashioned and obsolete instruments, chiefly levels and theodolites, which had accumulated in the repairable stock. They recommended that a portion should be condemned entirely and broken up, and their component parts utilized for other purposes and that a certain number should be disposed of at reduced rates; but for the largest number the Surveyor-General obtained the sanction of Government for an additional grant of ₹120 per mensem for five years, for extra workmen to be employed on converting the old instruments to modern patterns. A commencement was made in July 1889 and already a number have been converted and issued. On an average, 50 old instruments will be converted yearly, by which the indent on England for new instruments will be correspondingly reduced in value by about ₹15,000, whilst the cost of conversion will amount to not more than ₹2,000.

436. During this financial year, 37,806 serviceable and 5,442 repairable instruments have been received into store, making a total of 43,248 instruments. The number of serviceable instruments has diminished, but their value is about the same as last year. The number of repairable instruments has increased considerably.

437. Table A (page lxxxviii of the appendix) shows the amounts of the debits against various offices and departments for instruments supplied and for work done. It also exhibits the credits for all instruments and materials returned to store. The value of issues and repairs executed was ₹2,09,277, somewhat less than last year; it would probably have been greater, but for the absence of the steam power mentioned previously. This amount includes the value of instruments purchased by the extra-departmental grant of ₹35,000.

438. The credits for instruments returned into store amount to ₹68,680, which is considerably more than last year. The cash sales were ₹9,807 against ₹4,545 in last year.

439. During the previous year 31,846 instruments were purchased in the local market for ₹35,252: in the year under review the number was 9,612 and the value ₹35,615.

440. The actual number of instruments which have been manufactured in the workshops is smaller than in the preceding year, but the value of the work

is almost identical. This is owing to the demand having been greater for more expensive instruments, which entail more time and labour on each. The figures are given below:—

	Number.	Value.
		R
1887-88	17,960	33,320
1888-89	11,220	33,082

The class and value of these instruments will be found in Table C (page xci of the appendix).

441. The number of principal instruments repaired in the workshop is 2,550, which is an increase of 50 per cent. on the number of last year. The total number repaired amounts to 3,186 as compared with 3,012 in 1887-88.

442. The profit and loss account of the workshop will be found at page xcv of the appendix. The result of the operations therein is an apparent loss of R2,926 as compared with apparent profits in previous years' statements. This apparent loss is due chiefly to the decrease of work done in the way of repairs for stock, in consequence of the fittings, &c., in the new workshop not having been in full working order for some time after removal from the old workshop: there is also a considerable increase in the item house-rent, due to the higher rates and taxes levied on the new building.

443. In June the Government decided that the Mathematical Instrument Office should be the place of deposit in the town of Calcutta for the Indian Standard Yard, and it was made over to the Assistant Surveyor-General in charge, who was authorised to make copies and issue them with his certificate; about 200 copies are in course of being made and after verification will be issued to the various Local Governments according to their requisitions.

444. Mr. Bolton, the Mathematical Instrument Maker, has been absent on furlough in England during the whole of the year under report. His work has been ably carried on by Mr. Marshall, the Assistant Mathematical Instrument Maker, aided by Mr. Theakston, who was brought out temporarily from England to render assistance during Mr. Bolton's absence. In addition to his ordinary work, Mr. Marshall has devoted a great deal of his leisure time to the preparation of a complete illustrated catalogue of all the instruments available for issue. This has now been published and will, it is hoped, prove useful to officers in enabling them to prepare their indents for instruments. Stock-taking has been steadily carried on during the year as leisure permitted.

445. The term of five years' apprenticeship of the three boys taken into the workshop in 1884 expired this year. They have been thoroughly trained, and have turned out good workmen, but contrary to expectation, great difficulty has been experienced in obtaining suitable employment for them in India. Under these circumstances it has been thought better not to entertain any further apprentices.*

* Colonel Rogers reports that Messrs. Marshall and Theakston have carried on their work with ability and zeal, and adds that it is to be regretted that the office will lose Mr. Theakston's services when his engagement expires in June next on Mr. Bolton's return. The Correspondence and Store Branches under Messrs. Gray and Campagnac have done their work in a most satisfactory manner.

II.—TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

446. The office embraces the following sections:—

(1) Correspondence, Accounts, and Records.
(2) Computing.
(3) Type-printing.
(4) Drawing and Compiling.
(5) Photozincography.
(6) Solar Photography.
(7) Miscellaneous, Meteorology, Store-godown, &c.

447. The principal work of this office as a whole is the final reduction and publication of the operations of the Trigonometrical Branch of the Survey Department, in the furtherance of which each of the first five sections mentioned above takes a share. These operations include the principal triangulation of the whole of India and secondary triangulation executed in connection therewith; astronomical determinations of azimuth and of latitude; electro-telegraphic determinations of differences of longitude, and spirit-levelling operations, &c. Advantage is also taken of the facilities afforded by the office for calculating observations for latitude, azimuth, height, &c., taken by explorers; and, of late years, a good deal of work has been done in this respect, not only in connection with explorations carried out by the department itself, but also for officers of other departments.

Personnel.

Lieutenant-Colonel G. Strahan, R.E., Officiating Deputy Surveyor-General, in charge Trigonometrical Branch.
Lieutenant-Colonel T. H. Holdich, R.E., Deputy Superintendent, 2nd grade, in charge Drawing Section from 1st October 1888 to 16th April 1889.
Major St. G. C. Gore, R.E., Deputy Superintendent, 4th grade, from 1st January to 30th September 1889.
Captain R. A. Wahab, R.E., Deputy Superintendent, 4th grade, from December 1888 to March 1889.
Mr. E. C. Ryall, Assistant Superintendent, 1st grade, from 1st August 1889.
Mr. W. H. Cole, M.A., Deputy Superintendent, 2nd grade, in charge Computing Party from 23rd February 1889.
Captain S. G. Burrard, R.E., Officiating Deputy Superintendent, 4th grade, in charge Computing Party up to 22nd February 1889, and attached from 23rd February to 2nd May 1889.

(1) Correspondence, Accounts and Records.

Mr. F. A. D'Rozario, Head Clerk, and 3 other writers.

(2) Computing.

Mr. C. Wood, Surveyor, 1st grade.
Mr. W. H. Peychers, Surveyor, 2nd grade.
Mr. H. G. Shaw, Assistant Surveyor, 3rd grade, from 1st January to 30th September 1889.
Babu Gunga Pershad, Computer, retired on 8th July 1889.
Babu Kally Mohan Ghose, Computer.
Babu Kally Coomar Chatterjee, Computer, and 19 other computers, Records and Account-keeper and Librarian.

(3) Type-printing.

Mr. B. V. Hughes, Printer.
15 Compositors and Apprentices.

(4) Drawing and Compiling.

Mr. G. W. E. Atkinson, Surveyor, 1st grade.
Mr. N. C. Gwynne, Surveyor, 3rd grade.
Mr. C. H. McA'Fee, Surveyor, 3rd grade.
Mr. T. H. Rendell, Surveyor, 4th grade, up to 31st August 1889.
Mr. W. J. Cornelius, Surveyor, 4th grade.
Mr. E. A. Wainright, Surveyor, 4th grade, from 1st November 1888 to 30th September 1889.
Mr. H. T. Kitchen, Assistant Surveyor, 1st grade, from 1st September to 31st October 1888.
Mr. A. Kitchen, Assistant Surveyor, 1st grade, from 1st November 1888.
Munshi Yusuf Sharif Khan Bahadoor, Assistant Surveyor, 2nd grade, up to 31st March 1889.
Mr. H. Sindon and 6 other draftsmen.
22 Assistants and apprentice draftsmen and colorists.

(5) Photozincography.

Mr. C. G. Ollenbach, Zincographer.
Mr. J. S. Manuel, Assistant Zincographer, from 14th July 1889.
2 Photographers, 2 Native draftsmen, 1 Map-keeper.

(6) Solar Photography.

Mr. C. F. Guthrie, Assistant Solar Photographer.

448. The Drawing and Compiling section and the Photozincographic section, although existing primarily as auxiliaries to the Computing section, for the publication of maps, charts, &c., required to illustrate the survey operations, have also in course of time been taken advantage of for other work, such as the compilation and publication of exploration maps, charts of levels determined by Railway and Canal officers and reduced to the Great Trigonometrical Survey datum of mean sea level, and latterly the compilation and printing of trans-frontier maps. The Photozincographic section has further been made great use of by the Forest Department and the Quarter Master General's Department: during the last year nearly half the out-turn of its work was extra-departmental.

449. The 6th section, *viz.*, Solar Photography, was instituted in 1877, in compliance with the request of the Industry, Science and Art Department, South Kensington, conveyed through the Home Government, that solar photo-

graphs might be taken to supplement those obtained at Kew. At first the size of the photographs was only of 4-inch diameter, but on the recommendation of Mr. Hennessey, who was then in charge of this office, a new enlarging lens was sent out which increased the size to 8 inches, and later on a second large photo-heliograph was received which gives pictures of the sun 12 inches in diameter. This latter, owing to the cost of the glass and chemicals for working it, is only used when special features are present on the sun's surface.

450. The 7th section deals with the depôt of instruments and stores attached to it appertaining to the Great Trigonometrical Survey, of which it has for many years been the head-quarters, and also of a special instrumental equipment which has now to be maintained on a large scale. It includes the training of trans-frontier explorers, the instruction of departmental and other officers in taking astronomical observations, and in the use of instruments of the higher class. Scientific investigations in connection with the work of the Trigonometrical Branch are also made from time to time.

It deals also with some special meteorological observations.

451. To refer more particularly to the work of the past year, the office has been engaged in passing through the press the volumes of the accounts of the operations which will embrace all the principal work of the South Trigon. This is now drawing to a close, and it is hoped that the two large quarto volumes in which it will be published will be in the hands of the binder before many months have elapsed. Two other similar volumes containing the results of latitude observations at 111 stations will be issued about the same time; after which there will remain to publish of this series of volumes that containing the results of the South-West Quadrilateral, a volume of electro-telegraphic longitudes, another of astronomical latitudes and probably two on tidal work. The reduction for publication of trigonometrical operations was begun in 1867 and the following are the outcome up to date:—

Accounts of the operations, &c.—

Vol.	I.	Measurement of Base-Lines, 1870.
„	II.	Reduction of the North-West Quadrilateral, 1873-9.
„	III.	
„	IV.	
„	IVA.	Ditto ditto, 1886.
„	V.	Details of the Pendulum Operations, 1879.
„	VI.	Reduction of the South-East Quadrilateral, 1880.
„	VII.	Reduction of the North-East Quadrilateral, 1882.
„	VIII.	
„	IX.	Electro-Telegraphic Operations, 1875-81, 1883.
„	X.	Ditto ditto, 1881-84, 1887.
„	XI.	Astronomical Latitudes. In press, will probably be published this year.
„	XII.	
„	XIII.	Reduction of South Trigon. In press, will probably be published this year.
„	XIV.	

452. Synoptical volumes of the different chains of triangles, including the secondary work, have been published for the use of local officials and detail surveyors as follows:—

Vols. I to VII and VIIA, North-West Quadrilateral, complete.

Vols. VIII to XIII, and XIIIA, South-East Quadrilateral, complete.

Vols. XIV to XXI, North-East Quadrilateral. There remain two series of this Quadrilateral, for which Synoptical Volumes will have to be published.

453. In addition to the above publications, there are two volumes of trans-frontier work, and several pamphlets of the spirit-levelling operations which have now been extended throughout India. During the year the pamphlet entitled No. 4, Madras Presidency, was added to the list. A pamphlet on explorations in Sikkim, Tibet and Bhutan was compiled and published under the sanction of the Foreign Department.

In addition to the usual work of the office, assistance has been afforded to the astronomical parties to the extent of two computers for two months; and one computer was occupied for a month and a half in aiding in the reduction of the Hazara survey work.

454. As regards the future, the principal work of the South-West Quadri-

lateral is ready to send to press as soon as the volumes now in progress are cleared off, and considerable advance has been made in the reduction of the secondary triangulations of the South Trigon. One synoptical volume has been commenced, and it is hoped soon to have another ready for the press; and before these are printed others will also be ready to put in type.

455. In the Drawing and Compiling section the energies of the staff have been chiefly employed, as during the previous year, on the preparation of new trans-frontier maps, embodying all the recent knowledge that has been obtained. The section was under the supervision of Lieutenant-Colonel Holdich, R.E., until the middle of April, after which Major Gore, R.E., took charge and held it for the remainder of the Survey year. Very little time could be devoted by this section to the special work of the Trigonometrical Branch.

In addition to the new trans-frontier maps, of which a large number have been turned out during the year, the following may be mentioned as of general interest :—

Three sheets (Nos. 66, 81, 83, see index accompanying) of level charts in the Punjab, Map of Quetta Civil Station and North-East Trans-Frontier Sheet No. 7.

456. SOLAR PHOTOGRAPHY.—Photographs have been taken throughout the year on all days that the sun was visible, and the negatives have been sent to England to the Solar Physics Committee at South Kensington. These photographs serve to largely supplement those taken at Greenwich, and their results are included by the Astronomer Royal in the yearly volumes of Greenwich Observations.

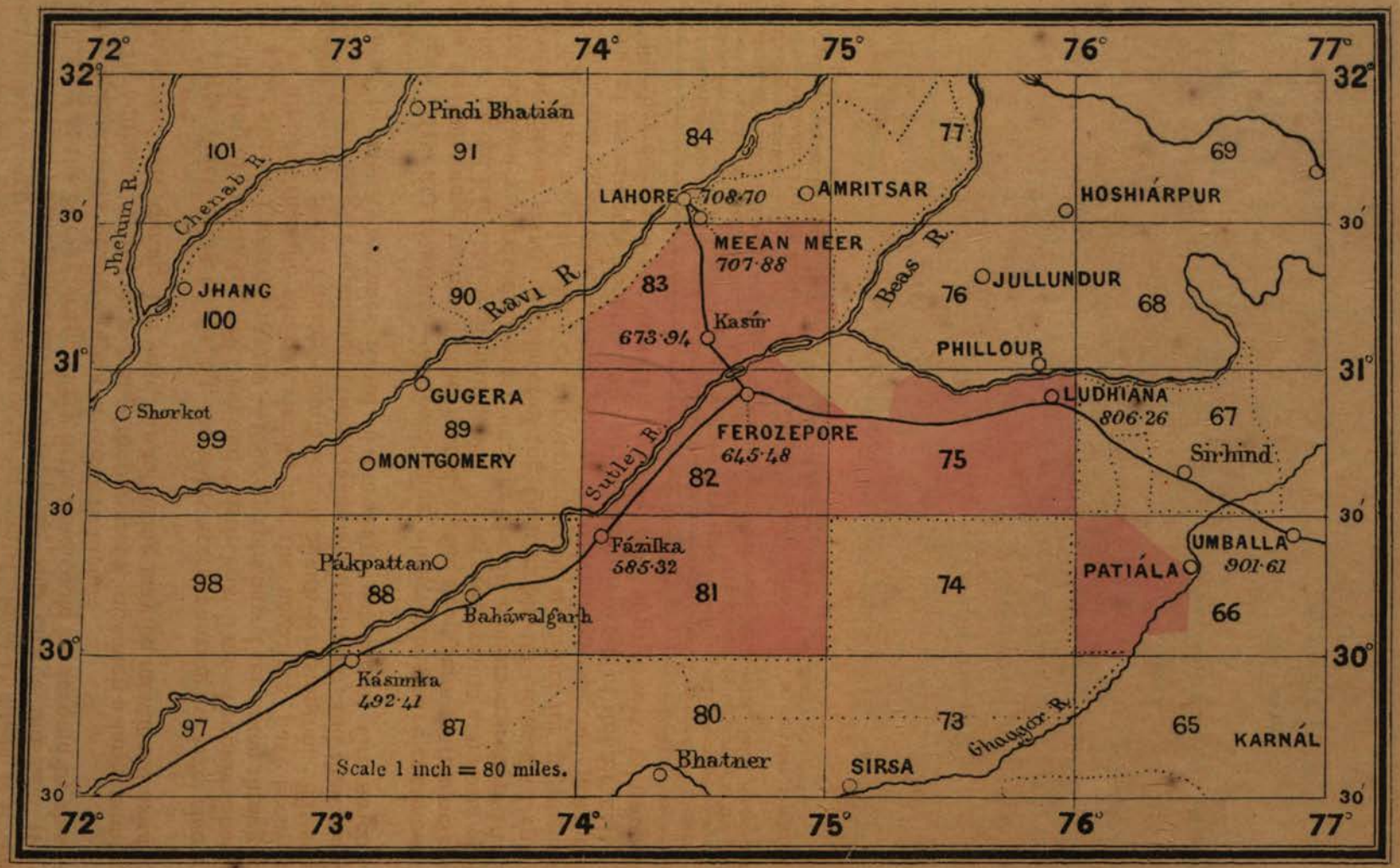
457. MISCELLANEOUS.—Meteorological observations have continued to be taken as heretofore, including the record of the deep sunk thermometers; the sunshine record has also been maintained. The preservation and issue of instruments has been supervised, as usual, and the special equipment referred to above kept in an efficient state. An officer of the Quarter Master General's Department was instructed in the taking of astronomical observations for purposes of exploration, and three departmental officers also received special instruction in the use of instruments appertaining to the scientific work of this Branch.

Further details of the work done will be found at page xcvi of the appendix.*

* Mr. Cole reports favourably on most of his assistants, making special mention of Messrs. Wood, Atkinson, McA'Fee, Ollenbach and Hughes, who stand at the head of their respective sections; also of Messrs. Peychers, Gwynne, Rendell, Wainright, Cornelius and Kitchen. He also bears testimony to the good work of Babu Cally Mohan Ghose and the other computers as well as of Mr. Sindon, Jafer Khan and Sham Lall Banerjee, draftsmen.

The Officiating Deputy Surveyor-General reports very favourably on the services rendered by Mr. D'Rozario, the head clerk, and Hira Sing and Abdool Razzak, clerks in his office.

EXTRACT FROM INDEX TO LEVEL CHARTS, PUBLISHED AND UNDER COMPILATION.



Published under the direction of Colonel H. R. Thuillier, R.E., *Surveyor General of India. November 1889.*

Sheets published on scale of 1 inch = 2 miles.

Great Trigonometrical Survey Main Series of levels are shown thus ○—○—○

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, November 1889

LIST OF MAPS AND CHARTS PUBLISHED DURING THE YEAR 1888-89.

Title.	Scale.	Number of Sheets.	Remarks.
Atlas of India.	In. M.		
Quarter sheets, Nos. 16 N.W., S.W.; 22 N.W.; 28 S.E., and 47 S.E.	1=4	5	
Quarter Sheets, Nos. 28 S.W. and 126 S.W.	1=4	2	With additions to 1888.
Sheet No. 54	1=4	1	With additions to 1889.
General Maps.			
Burma and adjacent countries	1=32	2	Without hills.
India	1=32	6	2nd edition, corrected to 1888.
Provincial Maps.			
Assam	1=16	1	With additions and corrections to November 1888.
Bengal	1=16	2	With additions and corrections to roads, railways, canals, &c., to January 1889.
Divisional Maps.			
Burdwan	1=8	1	
District Maps.			
Banda	1=2	2	
Hamirpur	1=2	2	
Ghazipur	1=4	1	
Part of Bhamo	1=4	1	Preliminary edition.
Chanda	1=4	1	With additions and corrections to boundaries to August 1888.
Chumparun	1=4	1	3rd edition corrected to March 1889.
Durbhunga	1=4	1	With additions and corrections to roads and boundaries to August 1888.
Mozufferpore	1=4	1	With additions and corrections to April 1889.
Sarun	1=4	1	Ditto.
Sibsagar	1=4	1	With additions and corrections to May 1889.
Standard Maps.			
Andaman Islands.			
Sheets Nos. 5 and 6 (in one) and 7 and 8 (in one)	1=4	2	
Bengal.			
Sheets Nos. 196 and 364	1=1	2	
Bombay.			
Sheets Nos. 102, 118, 181, 190 and 243	1=1	5	
Sheet No. 16	1=1	1	With boundaries corrected to 1888.
Burma (Lower).			
Sheets Nos. 143, 188, 233, 278 and 280	1=1	5	
Sheets Nos. 179 $\frac{\text{N. E.}}{1}$, $\frac{\text{S. E.}}{4}$; 180 $\frac{\text{S. E.}}{3}$; 181 $\frac{\text{N. E.}}{1}$, $\frac{\text{N. E.}}{3}$; 226 $\frac{\text{S. E.}}{4}$, $\frac{\text{S. W.}}{3}$; 227 $\frac{\text{N. E.}}{4}$, $\frac{\text{N. W.}}{1}$, $\frac{\text{N. W.}}{2}$, $\frac{\text{N. W.}}{3}$ and $\frac{\text{S. W.}}{2}$	4=1	12	
Sheet No. 8	1=8	1	Preliminary edition.

Title.	Scale.	Number of Sheets.	Remarks.
Standard Maps—contd.	In. M.		
Burma (Trans-frontier Series).			
Sheets Nos. 4 N.E., S. E.; 5 N.E., S.E.; 7 N. W., and 22 S.W.	1=4	6	
Sheets Nos. 4 N.W.; 22 N.W.; 23 N.W. and S.W.	1=4	4	2nd editions.
Sheets Nos. 1 N.E., S.E.; 2 N.E.; 4 S.W.; 5 N.W., S.W.; 6 N.W., and 15 S.E.	1=4	8	3rd editions.
Sheet No. 1 S.E.	1=4	1	2nd edition.
Sheets Nos. 7 and 23	1=8	2	
Sheet No. 22	1=8	1	2nd edition.
Central India and Rajputana.			
Sheets Nos. 387, 415, 416 and 417	1=1	4	
Central Provinces.			
Sheet No. 12	1=1	1	With boundaries corrected to 1888.
North-West. Trans-frontier Series.			
Sheet No. 30 S.E.	1=4	1	
North-West Provinces and Oudh.			
Sheets Nos. 101, 103, 107, 147, 170, 171, and 216	1=1	7	
Sheets Nos. 162, 181, 197, and 217	1=1	4	Preliminary editions.
Sheets Nos. 184 S E., 185 S.E., 200 N.E., S.E. and S.W.	2=1	5	
Punjab.			
Sheets Nos. 241, 242, 269, 270, 291, 292, and 313	1=1	7	
Sheets Nos. 267, 289, 290, 314, and 336	1=1	5	Preliminary editions.
Plans of Cities and Cantonments.			
Mandalay, showing Cantonment boundaries and disposition of troops	3=1	1	
Simla and Jutogh	6=1	1	2nd edition without hills.
Deesa Cantonment and Environs	8=1	8	
Quetta Civil Station	16=1	2	
Statistical Maps.			
India, showing percentage of cultivated area of Indigo	1=64	2	
India, to illustrate gauges of Railways	1=96	1	Corrected up to 31st March 1889.
Miscellaneous.			
Black Mountain and country adjoining Agror, 1869	1=2	1	Reprint with additions furnished by the Quartermaster General's Department.
Country adjoining Chittagong Hill Tracts	1=4	1	2nd edition.
Chin Hills	1=4	1	Preliminary edition.
Part of Karenni	1=4	1	Ditto.
Lushai and adjoining Hill Tracts, 1873	1=8	1	Reprint with additions supplied by the Quartermaster General's Department.
Ruby Mines, Upper Burma	6=1	3	
Do. do.	2=1	2	
Pambar Forest Reserve, Periyakulam Taluka, Madura District, Madras	4=1	1	
Triangulation Charts, &c.			
Nos. 10, 11, 14, 15, and 16 supplementary, of the East Coast Secondary Series, showing positions of beacons	1=2	5	Season 1887-88 (Provisional Issue).
Levels in the Punjab, sheet No. 81	1=2	1	2nd edition.
Do. do. do. No. 83	1=2	1	Ditto.

APPENDIX.

EXTRACTS

FROM

REPORTS BY EXECUTIVE OFFICERS.

UPPER BURMA TRIANGULATION.

Extract from the Narrative Report of MR. J. ECCLES, M.A., *in charge No. 24 Party—season 1888-89.*

Mr. Hickie left Rangoon on the 19th December, but before proceeding to his ground, he visited Toungoo for the purpose of meeting the Deputy Commissioner and making arrangements with him for interpreters, district peons, orders on the headmen of villages, and, if possible, for the hire of elephants. Everything was supplied except the elephants, and with regard to them, the Deputy Commissioner found himself unable to help Mr. Hickie, who then started for his field of work, reaching the first station by the 27th December. It had been arranged that the new series should emanate from the base Mya-ya-beng-kyo hill station—Theyekhu hill station, a side of one of the quadrilaterals of the Eastern Frontier Series, and should run up northwards about the meridian of 96°30′ in a series of quadrilaterals. Some secondary triangulation, executed in season 1876-77, had already emanated from this base, so Mr. Hickie was ordered to incorporate the secondary stations into the new series if they suited the purpose. On arriving at Mya-ya-beng-kyo, and examining the ground, Mr. Hickie resolved to adopt the first two stations, Bhongdown hill station and Toungi hill station, of the secondary triangulation, as it appeared that a good quadrilateral might be formed, only one ray of which had not been previously cleared. Mr. Hughes was consequently directed to visit Theyekhu hill station, the eastern flank station of the base, clear that hill top and open up the lines to the other stations, if found obstructed. Mr. Hickie laid off the ray for cutting from Mya-ya-beng-kyo hill station to Bhongdown hill station and then proceeded to the latter station, so as to lay off the direction of the ray from that station also, and thus carry on the clearing of the line from both ends; after a month spent over this line it was distressing to come on a ridge only about 7 miles north of Mya-ya-beng-kyo, which made it impracticable to see between Mya-ya-beng-kyo and Bhongdown. Both these stations on the left flank, are situated on narrow flat-topped ridges of the Pegu Yoma range, of uniform height and densely wooded; it was found impracticable to move off the ridge, and an intermediate station had consequently to be fixed on the obstructing ridge, which completely spoiled the quadrilateral, but nothing else could have been done owing to the nature of the ground. On the side Toungi-Bhongdown hill stations, another quadrilateral has been laid out. The station Thanadown at the north-east angle of the quadrilateral is one of the stations of the secondary triangulation, while a site for the other station has been selected, and the rays from it towards the other three stations of the quadrilateral have been partially cleared; but the signals were not seen, as by this date

a dense haze enveloped the whole country. A considerable time was spent at this station, but it was all wasted, as the haze did not lift, and Mr. Hickie was ordered to close work on the 15th April.

During the season two new stations were selected; three stations of the secondary triangulation were adopted; the two base stations were visited as well as two others of the secondary triangulation, and six pillars were built at different stations. The work may be said to be comprised in a single triangle and two quadrilaterals.

So far as can be judged from a cursory view of the country up to Mandalay remaining to be worked over, there is a promise of difficulty to be encountered in laying out the next two or three figures, as the range of hills within reach of the series on the western flank die out some miles north of Bhongdown, above which point all stations will probably have to be fixed on low ridges, if not on level ground. On the eastern flank, it is understood that the whole series right up to Mandalay will rest on a chain of hills varying in height from 1,500 to 5,000 feet. From the locality in which this season's work stopped, for a distance of about 50 miles northwards, there is a belt of dense forest to be cut through, after which it is presumed the difficulties will be trifling.

Mr. Hughes left Rangoon with Mr. Hickie. He visited Theyekhu hill station and cleared the hill top. While waiting for further instructions he made a plane-table survey of a portion of the country. At the beginning of February he was called in to act as Observatory Assistant, and was with the Executive Officer to the end of the season. All the assistants reported difficulties met with in procuring labour and transport. The Burman objects to leave home and work, and even if he allows himself to be persuaded to work for a few days, as soon as he gets a rupee in hand he runs away to spend it and will not return again without further persuasion.

The health of the party was far from satisfactory; fever and dysentery prevailed to an alarming extent. It was not unusual to have 30 per cent. of a squad down at one time.

Notwithstanding all the sickness, it was a matter for congratulation that there were only two casualties during the season; one man died from dysentery, while the other's death was due to the effects of injuries received from a tree falling on him while line-cutting operations were going on.

BURMA COAST.

Extract from the Narrative Report of MR. J. KEATING, *Assistant Surveyor, No. 24 Party—season 1888-89.*

Early in December I received instructions to carry a secondary series of triangles for the purpose of fixing beacons along the Burma Coast, from Pagoda Point (Lat. 15° 30′, Lon. 94°) to Sandoway (Lat. 18° 30′, Lon. 94° 45′). I left Rangoon on the 15th December 1888 and reached Bassein the following day. My first object was to gain all the information I could from the Deputy Commissioner and the Settlement and Forest Officers about the country to be triangulated; but the information I received was very meagre indeed, as this portion of the country is seldom visited by the district officials.

After visiting three of the stations of the Bassein Series, two on the eastern flank and one on the western, I found that all the stations on the western flank, instead of resting on the main ridge of the Arakan Yoma mountains, were on off-shooting spurs to the eastwards, and as the stations necessary for the work required would have to command a view of the coast, I had to abandon the idea of utilizing these stations. It would have entailed extending the triangulation from one of these bases through dense primeval forests on to the main ridge, and this I thought impracticable. I therefore telegraphed to Mr. Ryall asking permission to carry on a traverse along the coast from Maw Ding hill station (6 miles south of Cape Negrais) northward, and having received sanction to do this, I started from Bassein on the 1st January 1889 in a country boat towed by the Port Officer's launch, and reached Hain-ji Island at the mouth of the Bassein river the same evening. On the following morning I reached Pagoda Point and after some difficulty found Maw Ding hill station, over which the jungle had thickly grown. The upper markstone of the station was missing, but the position of the station was verified by observing an azimuth, the Alguada light-house being the referring mark. Maw Ding hill station is on the very extremity of the Arakan Yoma range, which terminates at Pagoda Point. The station is close to the well-known pagoda called Maw Ding, after which the station is named. The height of the top of the spire of the pagoda is 148 feet and its base being 74 feet above sea level, the height of the pagoda itself is 74 feet. The surrounding villagers hold the pagoda in great veneration, and in front of it there is a glazed house in which several candles are lighted every night. This point will form a conspicuous landmark for the Marine Survey. I started the traverse on the morning of the 4th January, but after going 6 miles over fairly good ground, I came to Cape Negrais, a wall of rock against which the sea washes, and I found that further traversing with the chain was impossible; I therefore set to work and made a subtense-bar, 10 feet long, with which I intended carrying on the traverse, and after giving it a sufficient test, I began using it. Most of the distances of the traverse from Cape Negrais northward were determined by the subtense-bar. Having cleared the summit of Cape Negrais of jungle, I opened out two rays looking northwards on to two points lying east and west of each other, the distance between which was obtained by measurement, and observed the three angles of the triangle to obtain the distance to these

points. I continued the traverse from the western end of the base. The above case was one of the many instances where triangulation had to be introduced into the traverse in order to get the distance to the forward station.

The first village of any importance after leaving Pagoda Point is Ngayôkkaung, which is about half a mile inland, on a large creek of the same name. It is the first village where the cocoanut palm is extensively cultivated and some trade is carried on between it and Bassein; the village is, however, chiefly remarkable for its boat-building, and a great number of boats are annually sold to traders between Akyab and Bassein. The next village of any importance is Hseng-ma and from here a pathway has been cut over the Yoma mountains to the Bassein valley; this is the usual route taken by travellers from Bassein to the coast, but traders, as a rule, prefer hiring a large boat and calling at villages where there is a creek and a prospect of trade. The next large village is some 40 miles north of Hseng-ma, and is called Bawmi, whence a route also exists into the Bassein valley. Bawmi was formerly a large thriving village, but an epidemic having broken out some seven years ago, the village was deserted and a temporary village erected on the opposite side of the creek. At this village the corpse of a Phoongyee (Burmese priest) who had died some two months before was still left unburied: this custom is observed when any priests or elders of the villages die, the corpses being eventually burnt. Bawmi is the last village of any importance in the Bassein district. The two largest villages in the Sandoway district along the coast are Kyeintali and Gwa. After getting into the Sandoway district, which begins with the last-named village, no more difficulty is experienced with regard to cooly labour or supplies, this portion of the country being quite accessible to the district officials. The principal headlands along the coast from Pagoda Point to Sandoway are Cape Negrais, Alligator's Head, Broken Point, Ta-beng-man Point, Ponta-man Point and Bluff Point; these headlands are very abrupt and the sea dashes against the walls of rock which form their sides. The coast is studded with innumerable islands and rocks and is dangerous for navigation, country boats even having to stand well out to sea.

The country traversed was very rugged, wild and thickly wooded, the jungle running down to the very sea shore, and in some cases heavy cutting had to be done to get over the ground. It is sparsely populated and labour was very difficult to procure and was expensive, wages being fully 100 per cent. above Indian rates. After completing about one-third of the traverse, I found that the villagers were very troublesome and would give no assistance. I had written for an escort to the Deputy Commissioner some four weeks previously, and on its arrival I was able to continue the work. The coast is intersected by innumerable tidal creeks which run a long way inland and are impassable at high water; most of these creeks are narrow and deep, but I have come across some fully one-third of a mile wide. This portion of Burma is very unhealthy; after I had been in the country two weeks, one-third of my men were struck down with fever, and after a month's residence only two of my men had escaped. At different times during the season I had to send my sick men into Bassein, and was eventually reduced to two-thirds of the original number, and these were in a very reduced state. There are no post offices along this coast until Sandoway is reached, nor is a policeman to be met with for 120 miles, their first station being at Gwa, which forms the boundary between the Bassein and Sandoway districts. The ordinary necessaries of life for the Indian, namely, wheat, ghee, dall, and condiments, are not procurable along this coast, but rice and fowls are to be had. The only way of getting about the country is on foot as the coast is too rugged either for ponies or elephants. Everything has to be carried by coolies and this makes the cost of working in this country very high.

After many difficulties and hardships I eventually closed the traverse on a secondary station of the Eastern Frontier Series called Bowendong hill station; here again I found the markstone missing and the cairn of stones protecting the station much disturbed. The damage, the villagers informed me, was done by wild elephants, and marks of these animals were visible all over the hill.

The total length traversed during the season was 157 miles, controlled by azimuths observed at eleven stations; fifty-three intersected points were fixed by intersections from more than two stations; these are either prominent headlands, rocks at sea, or the highest trees on islands or inland on peaks.

Five beacons also were specially constructed, three being on old secondary stations. These beacons consist of a stout pole of iron wood 9 inches in diameter at base, buried to a depth of 5 feet and standing out to a height of 25 feet above ground with a couple of cross arms 6 feet long, fixed a little below the top of the pole; the arms and upper half of the pole were painted white, and the lower half red. A pile of stones was set up around the base of the pole to a height of 4 or 5 feet above ground.

The linear error of the traverse is 1·7 feet per mile, and it is gratifying to me to find the error so small considering the many expedients that had to be resorted to in carrying on this traverse; it proves beyond doubt that the subtense-bar, carefully used, will give better results than the chain in rough and undulating country.

SOUTHERN MARATHA COUNTRY.

Description of the country surveyed by No. 10 Party during season 1888-89, by LIEUTENANT-COLONEL H. S. HUTCHINSON, *Deputy Superintendent, in charge.*

Sheet No 333 of the Bombay Provincial Index, embracing the tract of country between Latitudes $\frac{15°\text{-}15'}{15°\text{-}30'}$ and Longitudes $\frac{75°\text{-}30'}{76°\text{-}0'}$, consists principally of the Dharwar district, though small portions of the Nizam's territory also fall into it. The South Maratha railway runs through its northern portion from east to west, and Gadag junction of the Hotgi-Bijapur line falls nearly into the centre of the sheet, whilst Mulgund, Dambal and Lakkundi may be mentioned as the villages of principal importance falling within this sheet: the main road from Dharwar to Bellary also passes through it *viâ* Gadag and Dambal. The country is generally flat, and the scenery tame; but south and west of Dambal a low and rocky range of hills enters the south and centre of the sheet, and among the lower spurs of these hills, black buck, pig and hares are to be found, otherwise the country may be said to be void of game.

Gadag.—Gadag is a trade centre and cotton mart, and it has lately become an important junction of railways. It has two cotton presses, a ruined fort, two temples with twenty inscriptions, and there is also a branch of the Basel German Mission, besides the usual Government and railway offices. The temples are richly carved, and perhaps of all Dharwar buildings the little temple of Sarasvati takes the first place for delicacy and beauty of detail: the richness and grace of some of its columns are not surpassed. The whole temple, even to the figure of Sarasvati in the shrine, has been wrought with immense care and elaboration. The carving on some of its pillars is perhaps the most delicate in the Bombay Presidency. In the shrine sits Sarasvati cross-legged on a throne; it is a life-sized figure in black stone, most delicately and carefully wrought. At first sight the figure seems naked, but examination shows a fine textured garment with a prettily wrought pattern passing over the limbs. Sarasvati wears a very elaborate head-dress like a high crown. Round her neck a lavish profusion of necklaces, carved in imitation of beads, pearls, and other precious stones, falls gracefully over the bosom. Like her neck, her wrists and arms are heavily laden with ornaments. The cornice of the hall or *mandap* is made of large, flat, straight stones, sloping downwards at an angle of almost 45°, and projecting considerably over the pillars. Above the cornice is a moulding of horse-shoe arches surmounted by fame faces.

In a walled enclosure in Betgeri village is a group of fifteen old hero stones, which look like the huge old head-stones which have been found in some English graveyards. Of the fifteen stones the largest stands about thirteen feet above the surface of the ground: the faces of the stones are generally divided into three sculptured panels or compartments. The lowest panel shows a battle scene, where the deceased met his death, he himself figuring in the panel as the hero of the fight. Some of the stones in this panel have a plough or an oil-mill carved, perhaps, to mark the caste of the deceased. The second panel shows the deceased being carried to the gods between winged figures. The first or top-most panel shows a god, or the hero, seated on a throne. The tops of the stones are cut into long Dravidian roofs with an iron on the top. Several of these stones have inscriptions in old Kanarese characters, and one with the largest inscription is just in front of the village gate: a platform has been built round it and a small *ling* set before it. The stone itself is black and caked with dry oil, which is daily applied.

Mulgund.—Mulgund, about twelve miles south-west of Gadag, with (in 1881) a population of 5,386 souls, is an old town with several temples and inscriptions. There are nine chief temples: five Brahman and four Jain. The five Brahmanic temples are Kalbhairav, Kumbeshvar, Nagaresh, Peta Basappa and Siddheshvar; the four Jain temples are of Chandranath, Parshvanath, Hiri, and one of which the name is not known. Kalbhairav's temple has a large Bhairav inside with two inscriptions; Kumbeshvar has an inscribed stone sunk in the earth; Nagaresh has two inscriptions, one in front of the temple door, dated 1062, and the other in the wall outside to the left of the temple, the date of which has not been made out; Peta Basappa has two worn out inscriptions, dated 1207. Siddheshvar has, in the temple court to the left of the entrance, a rudely cut inscription on a narrow stone. Chandranath's temple has three inscriptions, one dated 902, belonging to the Rashtrakuta King Krishnavallabha or Krishna II (875-912); the second, dated 1275, records the death of Bhawatti, wife of one Madaras, ruling at Mulgund, and the third on a pillar in the temple, bears date 1675. Behind the temple is a large rock with an unfinished carving of a figure twenty-five feet long and an inscription partly worn out. The Hiri temple has two inscriptions, one of them dated 1275. The unnamed Jain temple has two inscriptions, dated 902 and 1053. Three other inscriptions remain in Mulgund, two being in a monastery called Andánsvami's *math*, both dated 1224, and the third dated 1170 is in a private house. To the east of the town is a small hill about 300 feet high, where a large fair is held in Kártik or November-December. People take to the hill-top a slipping stone or *jarbandi*, and let themselves down on it after the fashion of our modern tobogganing slides.

Dambal.—Dambal is about 12 miles south-east of Gadag; it has a fine lake about 300 years old, formed by an earthen dam 4,000 feet long and about 25 feet high, protected by a

massive retaining wall of stone. The lake was originally a very fine work, but it has now much silted up, and much of it is overgrown with *bábhul* forest. The water surface is about 300 acres, whilst the catchment area is about 46 square miles. It has been repaired and improved several times; in 1877-78 the storage water was increased 6 feet, and a distribution channel 1½ miles made. It has a good traveller's bungalow, and black buck, pig, duck, and hare shooting is obtainable within short distances.

Lakkundi—Lakkundi, situated 7 miles south-east from Gadag, is a place of antiquarian interest, with about 50 temples and 35 inscriptions. The temples are of various degrees of size and beauty, and are said to have been built by the mythic architect, Jakhanacharya. Great artistic skill is shown in the stone-carvings of many of the larger temples; the work somewhat resembling Chinese ivory-carving. Kashivishveshwar is the finest and one of the largest temples in Lakkundi. It is double, having a western temple including a shrine, hall and porch, and facing it an eastern temple with a shrine and a small ante-chamber. The porch of the western temple is joined to the ante-chamber of the east temple by a little raised platform surrounded by a low parapet. The two doorways of the hall on the south and east are beautiful specimens of delicate chiselling. The mouldings up the sides and round the top are chiefly square; they are most elaborately wrought with scrolls and figures, and in some of the mouldings the patterns are so cut away behind that the work has the appearance of beautiful fretwork, standing forward from the door post, and only fixed to it up the sides. Among these mouldings there are beautiful scrolls of foliage, a scroll with a little figure in every twist, a line of little pairs of figures with conventional clouds between them, another of griffins, rampant one above the other, so arranged that their bodies form a scroll. Another scroll is a lozenge-shaped flower, repeated with little beads, with foliage filling the angles; and one is made of little squares, in each of which snakes are most ingeniously twisted and knotted together. In the middle of these square mouldings, on either side of the door, runs a slender projecting pilaster, the shaft of which is in sections, square, octagon, sixteen-sides and round by turns, and prettily hung with festoons of beads and ornamented in various other ways. On the central projecting blocks over the doorways is Gaja-Laksmi or the Lakshmi with elephants. The southern doorway has a row of detached and inserted small standing figures over the top under the cornice, and both doors have figures on either side at the bottom of the mouldings. The pillars in the interior, four of which support the dome of the hall, are elaborately worked. The shrine doorway rivals the others in design and workmanship. On a raised plinth, on one side of the hall, is a row of female figures representing the goddess Saptashati or Chandi in her angry mood. The ceilings are poor compared with the rest of the building, being ornamented only with a central rosette or lotus, and a little filigree work in the corners. The exterior of the wall of the hall is divided into panels by their pilasters, and in each of these pilasters is a little canopied niche. On each of the south, west and north faces of the walls of the shrine is a prominent niche surmounted by a deep projecting cornice and a little tower above of the northern type. Above this again, and embracing the top of the tower, is a trefoil canopy dependent from a fame-face or *kirtimukh*. The tower or *shikhara* with canopy is repeated in each course of the spire. On either side of every niche are six panels, each depicting a mythological scene: the niches round this shrine are empty, though several round the eastern shrine have figures in them. On a stone called *Samadhikallu* in this temple is an inscription dated 1198.

Sheet No. 332 is singularly flat and uninteresting; the entire country contained in it is one stretch of very lightly undulating black cotton soil, without one hill worthy of the name to break the horizon line, the highest point being at Kot Umachi on a hillock about 150 feet above the surrounding country. It is made up principally of the Ron *taluka*, also a portion of the Navalgund *taluka*, together with some of the Nizam's dominions. The town of Ron is perhaps the only one of any importance or interest falling into the sheet. At Ron there are seven small black stone temples, in one of which is an inscription dated 1180. The people are all skilful, hardworking and well-to-do cultivators. The climate in the rains and cold weather is pleasant, but in the hot weather very dry, and there is a great scarcity of good water. The Bennihalla is the only river of importance, and it passes through a very small portion of the sheet; in the north-west corner most villages have small ponds of drinking water, and some few have wells, but the water is brackish.

Sheet No. 244, comprised between Latitudes $\frac{15^\circ\ 30'}{15^\circ\ 45'}$ and Longitudes $\frac{74^\circ\ 0'}{74^\circ\ 30'}$, consists of a portion of the Khanapur *taluka*, Belgaum district, above the ghâts, and Savantvadi and Goa below the ghâts. The country is very hilly throughout, and the ghâts cross it from north to south about the centre of the sheet, dividing the country almost equally between the Konkan and Deccan. The average height of the country above the ghâts being perhaps 1,700 feet, and that below, very little above the sea level, four passes fall into the sheet leading from the Konkan to the Deccan, but they are only passable for mules and bullocks, and are fast falling into very bad repair, being little used. The climate on the edge of the ghâts is very healthy and pleasant, but communications, except along made roads which all run east and west, are very difficult, owing to deep rávines that cut into the ghâts, and are almost impassable. This part of the country was much disturbed during 1845, and the fort of Bhimgad gave some trouble. This fort is situated below the main line of the ghâts; it is on a conical shaped hill, on one of the low spurs, standing as it were on a basin surrounded on all sides at some distance by higher mountains. The summit of the fort is formed by some 300 feet of perpendicular precipice, accessible only by one narrow path,

capable of admitting at most two or three men abreast; the top of the fort is flat and about 1,380 feet long north and south, and 825 feet wide east and west; the fortifications are now out of repair, and the place of little consequence. The sides of the hill and the neighbourhood abounds in wild animals, panthers, wolves, pigs, bisons and a few tigers and sambar.

"Darshinga" is the name of another commanding hill, standing out from the ghât, which affords much cover and many advantages for defence. During the Mutiny, in February 1858, one or two hundred men having attacked the Police Post at Talevadi retired to this hill, and a force had to be sent out against them from Belgaum, which managed to dislodge them, but failed to cut off their retreat, and the surrounding hills were for some time disturbed. The gang was however broken up in 1859.

The topography of this sheet is exceptionally difficult, both from the rugged nature of the hills and from their being densely covered with jungle; the climate, though cool, is very feverish.

A considerable trade in cinnamon bark is carried on from these hills, especially from Darshinga hill, where I met strings of coolies loaded with this spice.

The country below the ghâts is very hot, and survey work arduous, being unhealthy in the cold weather and exceedingly steamy and unpleasant in the hot season. It is much cut up with creeks, and the foliage is thick and high, so that communications are difficult and long distances can seldom be seen, except to tops of hills. The inhabitants of Goa territory do not seem to be under authoritative control or inclined to help the public service.

I was a good deal impressed with Tullewari, as affording a good site for a sanitarium: there is a small police bungalow there, and the climate is most pleasant even in the hottest weather. It is easily accessible, being only 17 miles by a made road from Khanapur Railway Station. There is plenty of flat plateau ground close to the edge of the ghât, affording room for building or cultivation, while the supply of water is naturally good, and could be greatly increased by artificial irrigation without any very great expenditure.

Kulkumbi is another favourite camping ground on the Chorla Ghât road; a weekly market is held there, so that provisions are easily procurable; it is about 25 miles from Belgaum by a cross country, but good bullock-cart road, by which much fruit and vegetables find their way from the Konkan to Belgaum.

Latitude Operations.

Extract from the Narrative Report of Mr. J. Eccles, M.A., *in charge Nos. 22 and 23 Parties (Astronomical)—season 1888-89.*

Before leaving Dehra I received instructions to observe for latitudes with Zenith Sector No. 2 at the following stations about the meridian of 80°: Díwai, latitude 19°50′; Ankora, latitude 19°25′; Burgpaili, latitude 18°57′; Rámgír, latitude 18°35′; Bolíkonda, latitude 17°43′; Niálamari, latitude 17°2′; and Dhúlipalla, latitude 16°26′; the first station being in the Central Provinces, the last in the Kistna district of the Madras Presidency, and the remainder in the Nizam's dominions.

I arrived at Warora in the Central Provinces on 28th November, where I had a latitude pillar built and took a series of six nights' observations. These were finished on 17th December.

I arrived at Kauarji, 3 miles from Díwai, on 28th December and put up the instrument next day. I took three programmes of 36 stars each and finished observations on 4th January, having obtained 97 double observations. The barometer sent from Dehra arrived in good order on 2nd January. Unfortunately at this and the next station there were no readings of the temperature of the external air taken, owing to my misinterpreting a passage in the observatory memo book. In fact, at this station no temperatures at all were taken on the first three nights, and only the readings of the thermometer attached to the barometer on the other three nights. The temperatures are accordant during these three nights, and may be presumed to have been so for the other three; so that a mean of the last three nights will probably give a close approximation to the real temperatures on the first three nights. The country round this station is covered with a very dense jungle which necessitated a considerable amount of line-clearing.

I left Kauarji on 6th January and arrived at Porsa after two marches. The whole of the 8th and part of the 9th were occupied in getting the carts over the Wardha river, which is a fine stream about 200 yards wide, the crossing being accomplished by means of boats dug out of trunks of trees. I arrived at Arapalle, the village nearest Ankora, on 10th January, and finished work there on 18th January, having obtained 104 double observations.

The hill of Ankora is extremely steep on the side next Arapalle, and the straight pathway is impracticable for laden coolies; the other road was 5 or 6 miles in length and all supplies had to be brought by it from the village. Here I must mention the great kindness shown me by the Amaldar of Tandur, who camped at Arapalle all the time I was in the neighbourhood, and also by the Tahsildar of Sirpur.

I arrived at Burgpaili on 25th January after making four marches through country covered with dense tree jungle. Owing to the pillar not being ready I was unable to begin

work until 30th January and finished on 4th February, having obtained 103 double observations. The camp left Burgpaili on 6th February and crossed the Godavery river the next morning. The crossing was rather difficult for carts, not so much on account of the water, which was about 2 feet deep, as on account of the long stretch of loose sand.

I arrived at Begumpete, a village at the foot of Rámgír hill, on 9th February, but owing to the difficulty of transport it was the evening of the 11th before I was established on the hill. The face of the hill or platform on which the Fort of Rámgír stands is a sheer precipice of about 1,200 feet high, and the only road to the station is a zig-zag one up this face and through the fort, which is now in ruins. I began work on 13th February and finished on 18th February, having obtained 100 double observations. The wind at this station was very troublesome; it began to blow each night about 10 P. M. and lasted till about 10 the next morning.

I left Begumpete on 20th February and got to Topanpalli, 2 miles from Bolíkonda, on 27th February. I began work at Bolíkonda on 1st March, and finished on 8th March having obtained 101 double observations. At this station I took four programmes of 26 stars each instead of three of 36 stars each. The hill on which the station stands is a very steep, rocky one, some 1,500 feet high. It is apparently a sacred place, and a great amount of labour has been spent in protecting the cliffs with blocks of stone and in hewing a tank out of the solid rock. Close to the station there is a curious stone about 12 feet by 6 feet by 3 feet, which, when struck, gives forth a loud metallic sound exactly like that of a brass gong.

I left Bolíkonda on 9th March and arrived at Malkápuram, the village nearest to Niálamari station, on the 13th March. I started work at Niálamari on 15th March and finished on 22nd, having observed on eight nights and obtained 100 double observations. The hill on which the station stands is one large mass of granite, which appears to be gradually slipping away in layers about 3 feet thick

I left Niálamari on 23rd March and crossed the Kistna river from Wádapalle to Pondagul on 25th March. The scarcity of water in these districts may be judged from the fact that there was only about 18 inches of water in the river. From Pondagul to Dhúlipalla there is a fine metalled road and I was able to make longer marches and reach the latter village on the 27th March. The station is about a mile from the village and in the middle of black cotton soil fields. The heat at times was very great and there was no shade near the observatory. Owing to clouds and rain I did not begin work till 30th March and finished on 5th April, having taken 102 double observations. I tried to make up three programmes; but this I found to be impossible owing to the scarcity of South stars. I had to content myself with two programmes, one of which I observed twice over. I left Dhúlipalla on 6th April and arrived at Guntur on 8th April when the party was disbanded.

At all stations at which I observed, the latitude pillar was built on the trigonometrical one. I dispensed entirely with the use of collimators and kept my instrument in the meridian by means of natural meridian marks, seldom moving it when the azimuth star was in the field. The various eccentricities of the instrument have been previously dealt with at length by Lieutenant Burrard, and I need only say that I found them all existing, sometimes to a greater and sometimes to a less degree. During the whole season the health of the party was extraordinarily good; with the exception of one man who died at Warora before I arrived, there was not a single case of a serious nature while the parties were in the field. This is more to be wondered at as the country as far as Rámgír is covered with jungle and enjoys a very unenviable reputation for health, and during the whole season the water was far from good.

TIDAL OPERATIONS.

Extract from the Narrative Report of MR. G. BELCHAM, *in charge No. 25 Party—season 1888-89.*

* * * * *

Observations have now been taken at twenty-nine tidal observatories, of which twelve have been closed on the completion of their registrations, and seventeen are now working. The stations of Okha, Hanstal and Nowanar, in the Gulf of Cutch, at which the observations were taken for about a year only, for a special purpose, and the station of Káthiwadar, at which observations without a self-registering gauge were taken by the Bhávnagar State for 13 months, are not included in the above.

There are now two sets of self-registering tidal instruments not in use, and during the year 1890 two more, *viz.*, those at Colombo and Galle, will be available for use at other stations.

Of these, one set of the old pattern has been sent to Messrs. Légé & Co., under orders from the Deputy Surveyor-General, for modification according to the new pattern instruments; this, when returned, will be sent to Aden for use instead of the set now working there, which being of the old pattern will also in its turn be sent for modification; one set will be erected at Diamond Island at the mouth of the Bassein river; one at Trincomalee and one at Minicoy, as soon as the observatories at these places have been con-

structed, the arrangements for which will be made, and the sites selected, during the coming field season.

The observatory at Shiyálbet (Sálbet), on the southern coast of Káthiáwár, which was sanctioned as a tidal station in February 1889, has not yet been completed; the site for the observatory was selected by Colonel Rogers in company with Mr. Proctor Sims, the Bhávnagar State Engineer, and the instruments for use in it have been obtained from Messrs. Légé & Co., London, and are the property of the Bhávnagar State.

I shall now briefly describe the working of each observatory, commencing with Aden and Kurrachee, following the order of the stations round the coast.

Aden.—The registrations by the tide gauge were almost perfect, there being only one interruption of 10 hours owing to the stopping of the driving clock, and five more, ranging from 2 to 5 hours, which were caused by some imperfection in the pencil marker.

Of the two self-registering aneroids at Aden, the one by Adie was at work from the 1st to 23rd October 1888, when it was found that it had been out of order for some time past; it was in consequence dismantled and sent to Messrs. Légé & Co., for repair, and the second or reserve instrument was cleaned and set going the same day, and has continued to work without interruption ever since.

The self-registering anemometer has worked continuously throughout the year and the only fault in the registration is that on the 22nd October, when the diagram was changed, it was wrongly set to 9 A.M. instead of 10 A.M.

The cistern of the mercurial barometer was found to be cracked, which rendered the instrument useless; it was accordingly taken down on the 23rd October and sent to the Mathematical Instrument Office, Calcutta, for repair, and was returned to Aden on the 26th June and set up the day after. The readings at 7 and 10 A.M., and 4 and 6 P.M., between these dates, were taken from a mercurial barometer which was kindly lent by Captain Falle, the Port Officer, who supervises the work performed in the tidal observatory. The aneroid barometer which was sent for repair has been received from Messrs. Légé & Co., and will be taken to Aden when the next inspection takes place.

The observatory was inspected by me between the 18th and 24th October 1888, when all the instruments were cleaned by the native mechanic of the party who accompanied me.

Kurrachee.—The tide gauge has worked satisfactorily; there were only three interruptions in the registrations caused by the stopping of the clock for a few hours at a time, and one of about 4 hours, when the wire attached to the pencil weight broke. There were also a few irregularities in the formation of the curves caused by the float weight coming in contact with the lid of the cylinder during unusually low water in the early part of November, and from imperfect communication of the water into and out of the cylinder. On the 7th, 8th and 9th June cyclonic weather was reported, when the tide rose from 1 to 2 feet above the predicted values, which is quite unusual at Kurrachee, the actuals being always very close to the predicted values. The clock of the tide gauge was removed and cleaned twice by the Harbour Works mechanic.

The self-registering aneroid got out of order on the 4th October 1888, and was taken down for repair by the Harbour Works mechanic; it was set going about a week afterwards; but Colonel Rogers during his inspection of the observatory in November found that the aneroid had not been working properly since the 19th July 1888, when the diurnal rise and fall began to be very slightly indicated, and after the 28th October ceased to be marked at all. The instrument was cleaned and adjusted on the 7th November, since which date the registrations have been continuous and the diurnal rise and fall correctly marked.

The self-registering anemometer at Kurrachee belongs to the Port Trust; there were several breaks in its registrations between the 1st October and 14th December, owing to some parts of the instrument being out of order; these were partly repaired by the native mechanic of this party and partly by the Harbour Works mechanic, but since the 15th December no further interruptions have been reported.

The rack of the mercurial barometer which was reported in the last Annual Report as being out of order was repaired by the native mechanic of the party in November, but it again got out of order on the 5th August and no readings of this instrument were taken for about a week, while it was being repaired by the Harbour Works mechanic.

Colonel Rogers inspected the observatory between the 4th and 9th November, during which time several instruments were thoroughly cleaned, repaired and adjusted. Sub-surveyor Dhondu Venayek and the watchmaker of the party accompanied Colonel Rogers.

The observatory at Kurrachee is well looked after by Mr. Price, the Port Engineer, who takes a great interest in the tidal observations.

Bhávnagar.—The record of the self-registering tide gauge for the year has been satisfactory; there have been the usual fortnightly interruptions of about 3 hours caused by the flushing out of the cylinder. The clock stopped on six different occasions, causing breaks of from 6 to 13 hours' duration, and finally there were 17 other short breaks, owing to accidents to the communication pipe, the repairs of which were speedily attended to under the direction of the State Engineer.

The registrations by the self-registering aneroid were very satisfactory, there being only two short breaks of a few hours each, while the instrument was being cleaned.

The self-registering anemometer has worked very satisfactorily; there were only four breaks in its record, caused by rain water getting into the works; by the fans becoming

loose, and by the breakage of the cord attached to the clock weight; and as the necessary repairs were immediately made there was only a stoppage of a few hours on each occasion.

The Bhávnagar tidal observatory was inspected between the 14th and 18th November by Colonel Rogers, who was accompanied by the native mechanic of the party and by sub-surveyor Dhondu Venayek; and during the inspection the several instruments were cleaned.

The State Engineer, Mr. Proctor Sims, takes a deep interest in the work of the tidal observatory, and no pains on his part are spared to get as complete a record as possible of the tides.

Bombay (Apollo Bunder).—The tidal registrations at this observatory have been very complete throughout the year, the only breaks being one of 5 hours on the 6th December 1888, when the gauge was being cleaned during an inspection, and another of 3 hours on the 1st May 1889, while the old pattern gauge which had been at work since the observatory was established, was being dismantled, and the new pattern gauge from the Mormugáo tidal observatory was being set up in its stead. The graduated staff has been reported to have been out of order and under repair on four occasions, and the clock of the tide gauge during the month of May had to be frequently regulated.

The old pattern tide gauge after being dismantled was sent to Poona, and has since been despatched together with an aneroid barometer and an anemometer which were very much out of order, through the Marine Storekeeper, Bombay, to Messrs. Légé & Co., London, for modification and repair. They are intended for use at Aden, where also there is an old pattern gauge; the only other old pattern instrument is at present working at Madras.

There is neither aneroid barometer nor anemometer in the observatory.

The observatory was inspected twice by Colonel Rogers: once in December, when the gauge was cleaned and 5½lb of water were found in the float; and again in May for the purpose of effecting the change of instruments. Another inspection was made by Mr. Eccles in company with myself on the 9th August, when the hairspring of the clock being found out of place was set right.

Bombay (Prince's Dock).—The gauge which was set up in this observatory on the 22nd September 1888 has worked without a single interruption since the 25th February, but prior to that date the clock stopped on 13 different occasions, causing breaks in the record ranging from 8 to 21 hours; the pencil through some mishap failed to mark for a few hours on the 3rd and 4th October and 11th December; and on three occasions the escape of steam from the Electric Light Engine, which is in the same building as the tide gauge, damaged the diagram paper and prevented the pencil from marking the curve properly.

In this observatory also there is neither aneroid barometer nor anemometer.

The Prince's Dock observatory was inspected by Mr. Eccles in company with myself on the 10th August, when the work was found to be carried on in a satisfactory manner.

Mr. Squire, the Acting Port Trust Engineer, Bombay, supervises the work carried on in the two observatories at Bombay, and I am much indebted to him for his very able assistance.

Mormugáo.—The self-registering tide gauge has only two interruptions of 9 and 5½ hours, respectively, in its record between the 1st October 1888 and 27th March 1889, on which latter date it was dismantled after completing 5 years' registrations.

The anemometer observations for this period were uninterrupted and were recorded by a large instrument belonging to the Western India Portuguese Railway.

The self-registering aneroid by Légé also worked uninterruptedly during the same period.

The observatory was inspected by Colonel Rogers between the 24th and 27th March, who after taking the necessary measurements for zero, and levelling observations between the bed plate of the tide gauge and the adjacent bench-marks, dismantled the observatory and sent the tide gauge to the Bombay (Apollo Bunder) tidal observatory, and the aneroid barometer to Poona. Sub-surveyor Dhondu Venayek accompanied Colonel Rogers in his inspection. The bench-marks were placed in charge of Mr. Pemberton, the Harbour Engineer, who lately supervised the work performed by the clerk. The observatory was sold to the Western India Railway Company, and the money realized was paid into the Poona Treasury.

Cochin.—The self-registering tide gauge has worked very satisfactorily, the only interruption in the registration was one of 6 hours on the 10th July, when the native mechanic of this party arrived from Poona and took in hand the repairs of the clock, the pivot of which was reported by telegram, by the Port officer, to have broken on the 1st July, and could not be repaired by the local watchmaker. No time was lost in sending the mechanic down and fortunately while he was on his journey the clock continued to work, but was losing several minutes each day. This however does not make the observations useless, as the necessary time correction can be easily applied.

There was no regular record by the self-registering aneroid at this station between the 1st October 1888 and 23rd February 1889, owing to its clock being out of order, but readings were taken daily at 7 A.M., 10 A.M., 4 P.M. and 6 P.M. On the latter date Colonel Rogers during his inspection set up the instrument which was brought away for repair last year from Mormugáo, and its record has only five interruptions, three caused by the stop-

ping of the clock and two while the clock was being cleaned by the mechanic, who took advantage of attending to it, when he was at Cochin in July.

The self-registering anemometer has worked well, there being only 6 short breaks in its registrations, owing to the stopping of the clock.

The observatory was inspected in February by Colonel Rogers, who was accompanied by sub-surveyor Dhondu Venayek, when the several instruments were cleaned and another clock was attached to the anemometer.

Captain Winckler, the Port Officer, has supervised the registrations as before, and thanks are due to him for the interest he takes in them.

Colombo.—The self-registering tide gauge has worked uninterruptedly throughout the year.

The anemometer and barometer readings at this station are supplied by the Surveyor-General of Ceylon.

The usual 5 years' work was completed at this station on the 8th February, but as the registrations between the 1st November and 5th December 1885 were untrustworthy for the reasons given on page XXI of the Annual Report for 1885-86, Colonel Rogers decided upon continuing the observations for another year.

The observatory was inspected by me in June, when the gauge was found to be working satisfactorily; but a settlement of 0·074 foot was noticed to have taken place in the bed-plate. The tide gauge and its clock were thoroughly cleaned by the native mechanic who accompanied me.

Captain Donnan, the Master Attendant, has done all in his power to render the work as complete as possible.

Galle.—The tidal registrations at this station have been fairly good; there have been no stoppages of the clock; but owing to the axle of the stud wheel, supporting the float and band, becoming clogged with oil, it worked very stiffly and prevented the action of the float, which caused the pencil to mark vertical lines on 32 different occasions between the 12th November and 26th May. These imperfections in the daily curves lasted for various lengths of time, ranging from 2½ to 14 hours; but with a little trouble it is possible to complete the broken curves by interpolating between the preceding and succeeding day's curves. There is also a break in the registration between the 4th and 6th of June during which time the cylinder was under repair.

The barometrical observations at this station are not complete. The self-registering aneroid, by Légé, worked with one interruption until the 25th February, when it entirely ceased to work, owing to one of the pivots of the clock having broken. Its readings, however, were taken daily at 7 A.M., 10 A.M., 4 P.M., and 6 P.M., and on the 5th June, after the damage was repaired and the instrument thoroughly cleaned, the registrations were re-started and have gone on without a break ever since.

The record of the self-registering aneroid by Adie between the 20th July 1888 and 4th June 1889 was perfectly useless, as the instrument during the period was entirely out of adjustment, but since the 6th June, when it was repaired and adjusted, the record is satisfactory.

The registrations by the anemometer were very complete, as with the exception of a loss of work of about 19 hours, on the 7th and 8th June, the registrations were uninterrupted.

On the 8th April last the usual 5 years' observations were completed at Galle, but Colonel Rogers decided upon continuing the observations at this station as well for another year.

The observatory was inspected by me in June, when it was found necessary to remove the cylinder and have it repaired in the Harbour Workshop, as the holes for the ingress and egress of water had become very large, and the iron plate at the bottom had come off, which caused the pencil to move up and down incessantly over 6 or 7 tenths of a foot on the diagram. The tide gauge and its clock as well as the two aneroids and the anemometer were thoroughly cleaned and put into good working order by the mechanic of this party, who accompanied me.

The Master Attendant, Captain Blyth, has supervised the work carried on by the clerk in charge of the observatory, and has, as usual, afforded every help so as to ensure the completeness of the observations in which he takes a great interest.

Tuticorin.—The self-registering tide gauge at this station has worked uninterruptedly throughout the year. On the 20th October the wire between the pencil and its weight broke, but it was immediately repaired by the clerk.

The registrations by the self-registering aneroid were quite complete for the year, and so also were those by the self-registering anemometer; not a single stoppage of any kind having occurred in either of these instruments.

The observatory was inspected by Colonel Rogers in February, when the several instruments were found in good order. Sub-surveyor Dhondu Venayek accompanied Colonel Rogers on his inspection.

The work carried on in this observatory was supervised by Captain Phipps, the Port Officer, who retired from the service on the 20th June, since which date Captain Baker from Cocanada, who was appointed Port Officer at Tuticorin, has very kindly taken up the supervision; both these officers have done all in their power to render the work as successful as possible.

Madras.—The registrations by the tide gauge were not very satisfactory for the

year under report; there were a few short interruptions caused by the stopping of the clock and the breaking of the wires attached to the pencil and back-lash weight, between the 1st October 1888 and 6th March 1889, after which, for 3 days there was no record at all, as the clock was out of order and was undergoing repair by Messrs Orr & Sons, and subsequently, between the 21st August and 9th September, the record was imperfect, owing to the communication holes in the pipe being choked.

The self-registering aneroid has again been working very unsatisfactorily; the instrument was cleaned and adjusted during an inspection in February, when it was found to be out of order, after which it continued to work with a few interruptions until the 13th May; it was then sent to Messrs. Orr & Sons, and replaced a week afterwards, but it had to be sent back to them almost immediately, and finally, as the repairs could not be successfully carried out by them, the instrument was brought away to Poona at my direction, by the native mechanic of the party while on his way back from Cochin in July.

There is no anemometer working at this station.

The observatory was inspected in February by Colonel Rogers, who was assisted in the work by sub-surveyor Dhondu Venayek.

Cocanada.—The self-registering tide gauge has worked very satisfactorily; there were only four short interruptions in its registration, which were caused by the float band slipping off the stud wheel, owing to the latter having got out of shape: these accidents happened on the 15th, 17th, 18th and 19th April and were prevented from recurring, in the first instance, by a wooden guard which Captain Baker, the Port Officer, had fixed to the tide gauge stand, and finally by the wheel having been set right on the 19th May during an inspection of the observatory. The accident on the 17th April resulted in the chain between the pencil traveller and sheave breaking, but it was very speedily and carefully repaired by the clerk.

The self-registering aneroid worked uninterruptedly until the 18th May, but its record was of no value, as the instrument was then found to be entirely out of order and was brought away to Poona to be thoroughly overhauled and adjusted; it will be taken back when the next inspection is made.

The self-registering anemometer has worked uninterruptedly throughout the year.

The observatory was inspected by me in May, when the instruments were cleaned and the necessary repairs carried out by the native mechanic of the party.

Thanks are due to Captain Baker, the late Port Officer, and Captain Wicks, the present one, for the supervision exercised by them over the work carried on in this observatory.

Kidderpore.—The registrations by the tide gauge for the year were perfect, there being no stoppage of the clock; one short interruption, however, occurred on the 31st August, when the pencil wire at the clock-end broke, but it was at once renewed by the clerk in charge of the observatory.

The gold thread attached to the pencil marker of the self-registering aneroid came off its pulley on the 16th October, but was set right by one of the mechanics from the Mathematical Instrument Office, Calcutta, on the 25th idem, since which date there has been only one break of 3 hours in its registrations, which occurred on the 19th February: the work of the aneroid may therefore be said to be satisfactory for the year.

The self-registering anemometer has worked continuously throughout the year.

A full inspection of the observatory was made by me in February, when the several instruments were cleaned by the native mechanic of the party, and again while passing through Calcutta in May, I visited the observatory and found the instruments in adjustment and working well.

On Page xiv of the last Annual Report, it was stated that the observatory would have to be removed to another site, but as its present site was found not to interfere with the work in connection with the new Docks, it has been allowed to remain undisturbed for the present.

Lieutenant Petley, R. N., has continued to supervise the work carried on in the observatory, and thanks are due to him for his hearty co-operation in the tidal observations.

Chittagong.—The self-registering tide gauge has worked very satisfactorily; the only interruption in its registration being one of six hours on the 28th April, while the instrument was being cleaned during an inspection; its clock, however, on 23 different occasions, had an error of over three minutes, but the necessary corrections can be readily made before reading off the hourly curves.

The self-registering aneroid was sent to the Mathematical Instrument Office for repair on the 29th September 1888; it was returned on the 25th January, and set up in the observatory, where it worked until the 29th April. During this period there were only 3 stoppages of the clock, occasioned by the vibration of the wharf; but the record was not satisfactory, as it was found on the 27th April, during the inspection of the observatory, that there was a difference of $\frac{1}{10}$th of an inch between the pencil and the dial readings. On the 30th April the instrument was removed and set up in the Port Office, where it has been working ever since, and only 3 short stoppages have occurred up to date.

The mercurial barometer at this station was sent on the 30th March to the Mathematical Instrument Office for repair; it was returned to Chittagong on the 24th May and set up in the Port Office near the aneroid.

The anemometer has worked very satisfactorily, there having been only 2 interrup-

tions in its record, one on the 4th November, when the spiral failed to mark, and one on the 29th April, while the instrument was being cleaned.

The observatory was inspected by me in the latter end of April, when the instruments were cleaned by the native mechanic of the party.

The Lieutenant-Governor of Bengal while on tour at Chittagong visited the tidal observatory on the 28th April, and as I was at the time engaged in its inspection, I had the opportunity of showing him the use of the several instruments at work in it.

Mr. Good, the Port Officer, supervised the registrations, in which he takes great interest.

Akyab.—The tidal observations at this station were almost perfect, only 3 short breaks in the daily curves having taken place during the year, of which one of 5 hours occurred on the 22nd April, while the tide gauge was being cleaned, and the other two on the 12th June and 13th August, when the clock stopped for a few hours owing to vibration in the pier.

The self-registering aneroid had only one short interruption in its registration until the 21st April, when it was taken down for the purpose of being cleaned and adjusted, as it was then found that the instrument was very dirty and consequently out of order, from being infested with cockroaches; it was re-fixed the same day and only two short breaks have since taken place in the record.

The registrations of the anemometer are quite complete for the year.

The observatory was inspected by me in April and the several instruments in it were cleaned by the native mechanic who accompanied me.

The work of the observatory was supervised by Captain Finney, the Port Officer, who takes great interest in the registrations.

Rangoon.—The interruptions to the tidal registrations were less frequent than they were last year; on six occasions the clock, owing to the vibration of the wharf, stopped working, the band slipped off the stud wheel once, and twice it became entangled in the cylinder, but the breaks so caused did not in a single instance last longer than 16 hours; in addition to these breaks, there was a loss of work of nearly two days between the 29th June and 1st July, during the time the observatory was undergoing repair after its roof had been smashed in by the S. S. *Sirdana* while coming alongside the wharf.

The self-registering aneroid had 2 short interruptions of a few hours each in its record up to the 2nd March, when the instrument was cleaned during the inspection, and only two more since that date have occurred which also were short; but the record of the aneroid was not satisfactory as the vibration in the observatory affects the adjustment and renders the working of the instrument untrustworthy.

Between the 1st October 1888 and 12th March 1889, there were five unimportant interruptions in the work of the self-registering anemometer due to the stopping of the clock and one to the breaking of the wire attached to the weight, after which there was a continuous break of a month owing to the instrument being very dirty and the clock having one of its pivots broken; but since the 13th April, when it was repaired and cleaned, only one accident to the weight wire, which occurred on the 2nd June, caused a further break of an hour.

This observatory was inspected by me in March on my way to Mergui and again in April, when the tide gauge, aneroid and anemometer were cleaned and put into order and the standard bench-mark of reference for Rangoon was connected by levelling with the other bench-marks. The Elephant Point observatory site was also inspected, and a new bench-mark, which had been laid down at the Government Telegraph Quarters 1¼ miles from the site, by Mr. Reichenbach, the Port Engineer, at my request, was connected with the two bench-marks of reference of the tidal observatory.

Thanks are due to Mr. Darlington, the Vice Chairman of the Port Commissioners, and to Mr. Reichenbach, the Port Engineer, for the ever ready help rendered by them in all matters connected with the tidal work.

It is under contemplation by the Port Commissioners, Rangoon, to extend and alter the wharf on which the tidal observatory at present stands, and as this would render it necessary to dismantle the tide gauge, Colonel Rogers some months back addressed the Vice Chairman and brought to his notice that it would be unadvisable to have a break in the registrations at Rangoon owing to the complicated nature of the tides, and suggested that the compulsory movement of the observatory might be taken advantage of to have it in a safer and better place, and that it should be on its own piles and separate from the wharfs. Nothing definite, however, has yet transpired, but no doubt during the coming field season arrangements will be made to ensure the continuity of the observations.

Mergui.—The arrangements for this observatory were made last year and the building, which was constructed after the pattern of the one at Akyab, was finally completed and handed over to me personally by Mr. Bailey, the Executive Engineer, Moulmein, in the beginning of March 1889.

The observatory is situated 23 feet beyond the T head of the Mergui pier and rests on 4 substantial piles which have been driven about 16 feet into the bed of the river; it is accessible from the pier by a strong wooden bridge with a removable piece at the end to isolate the observatory. The superstructure is 12 feet square and is very neatly and strongly built, and its floor is 4 feet above the level of the head of the pier.

The float cylinder is of wrought iron, 30 feet in length and 2 feet internal diameter; it is in four lengths, each having a flange at top and bottom. The bottom of the cylinder

which rests on the bed of the river, is closed with a wooden lattice-work. Three sets of holes $\frac{3}{4}$ths of an inch have been bored in the bottom length for the ingress and egress of water, and on the 19th and 20th of March during the lowest spring tides of the year there was 2·5 feet of water in the cylinder, which is more than sufficient for the float to work in.

A graduated staff has been fixed to the south-east corner pile of the observatory; it is 15 feet in length and its zero is the same as that of the tide gauge; its readings are taken twice daily to check the level of the water in the cylinder.

The self-registering tide gauge, the self-registering aneroid and the mercurial barometer were placed in the tidal observatory, but the self-registering anemometer was set up in a separate wooden house, $3\frac{1}{2} \times 3\frac{1}{2} \times 6$ feet, which was erected for its reception on the roof of the northern section of the Court-house, situated on the top of the hill at Mergui, where the instrument is more exposed to the wind than it would have been had it been fixed to the roof of the tidal observatory.

The several instruments in use at Mergui form the set that was used at Diamond Harbour, where they were dismantled on the completion of the observations on the 12th April 1886. They were all thoroughly cleaned and adjusted before being set up.

The tide gauge at this station is working on the $\frac{1}{8}$th scale, the range of the tide at springs being over 20 feet.

The tide gauge and aneroid started work on the 24th March and the anemometer on the 30th March, and up to the present time, the tide gauge has only had two short breaks in its registrations and the self-registering aneroid eight, while the anemometer has worked continuously without a single failure.

There being no telegraph office at Mergui, a chronometer the error and rate of which were determined was left in the observatory for keeping the tide gauge and aneroid clocks to mean time.

Colonel Alexander, the Deputy Commissioner of Mergui, very kindly supervises the work performed by the clerk in charge of the observatory, and I am much indebted to him for the interest he takes in it. Great credit is due to Mr. Bailey, the Executive Engineer, Moulmein, and to his Assistants, Messrs. Foy and McLeod, for the excellent way in which the observatory has been erected, as the difficulties they experienced must have been enormous owing to the limited facilities for carrying on work of the kind at Mergui.

Mr. D'Zalazar, the Customs officer at Mergui, was deputed by the Deputy Commissioner to take charge of the observatory, and he has been performing his duties, which he was taught during my stay at Mergui, in a very satisfactory manner, his daily reports and returns being neatly prepared and regularly submitted.

Port Blair.—The tidal registrations for the year have been very satisfactory, the only interruptions in them being as follows:—one of 6 hours on the 6th November, caused by the float band slipping off the stud wheel; two of 10 and 13 hours on the 21st February and 30th April, respectively, caused by the stopping of the clock; one of 5 hours on the 1st June, owing to the pencil failing to mark; and one of 11 hours on the 23rd June, when the catgut attached to the pencil weight broke.

The registrations by the self-registering aneroid and anemometer were also very satisfactory, as they continued to work without a single failure throughout the whole year.

The observatory was inspected by me in February, when the several instruments, though found in good order and working well, were cleaned by the native mechanic of the party. During the inspection, Mr. Brookes, the Port Officer, spoke to me of the desirability of building a masonry well for the float to work in, in place of the iron cylinder which often had to be renewed from the effects of corrosion; it would indeed be a great improvement to the observatory, which is one of the permanent ones, and I hope before the present cylinder becomes useless, the well will have been completed.

Summing up the work at the various tidal stations described above, it may be concluded that the registrations have been very satisfactory throughout the year.

In addition to the regular observations by the self-registering gauges at the tidal stations above mentioned, the heights of the tide at the closed station of Moulmein have been taken twice daily, at high and low water, on the graduated staff, which was set up by Major Hill in 1887. These observations have been taken under the immediate supervision of Captain Dodd, the Port Officer, who very kindly forwarded them to this office for comparison with the actual values given in the Tide Tables.

Reduction of the Tidal observations.—During the year under report the amount of work done has been greater than in any previous year. The observations at 15 stations have been reduced, two years' calculations having been made in the case of 5 of them; so that the total out-turn is equivalent to 20 years' reductions at one station. The tabulated values of the tidal constants so obtained are appended. The discussions of the yearly results referred to on page xvi of the appendix in the last Annual Report could not be taken up, as the observations at a sufficiently large number of stations have not yet been completed to admit of final comparisons being made and conclusions being arrived at.

The meteorological computations which were taken up by Mr. Eccles and alluded to at the same page of the Annual Report for last year could not be proceeded with, owing to the corresponding tidal curves, which Mr. Roberts of the Nautical Almanac Office was desired to construct by means of the Tide-Predicter, not having been received up to date and consequently no further steps could be taken to select the best method of computing the observations and applying their results to the tides.

A table showing the present state of the ordinary tidal computations is appended;

in it is also shown the state they were in on the 30th September 1888. The letters A. P. in the table indicate that the actual times and heights of high and low water for 1888 were measured in duplicate from the tidal diagrams and compared with the predicted values contained in the Tide Tables for that year. The actual amount of work done during the year can thus be seen. The extra tidal work consisting of reports on the working of the tidal observatories in the Bombay Presidency and in Burma for submission to the local Governments is not shown in the table.

State of the ordinary reductions of the yearly tidal registrations at the beginning and end of the Survey year 1888-89.

Tidal observatory.	State at end of September 1888.	State at end of September 1889.
ADEN . . .	1886-87. Calculations completed. 1887-88. Diagrams not read off. A. P.	1887-88. Calculations completed. 1888-89. Diagrams not read off. A. P.
KURRACHEE . .	1886-87. Calculations completed. 1887-88. Diagrams not read off. A. P.	1887-88. Diagrams read off, the hourly readings being copied from the S. series into the other series. 1888-89. Diagrams not read off. A. P.
BHÁVNAGAR . .	1887. Calculations completed. 1888. Diagrams not read off.	1888. Calculations completed. 1889. Diagrams not read off. A. P.
BOMBAY (Apollo Bunder).	1886. Calculations completed. 1887. Diagrams not read off. A. P.	1887. Calculations completed. 1888. Calculations completed. 1889. Diagrams not read off. A. P.
BOMBAY (Prince's Dock) Started September 1888).		Newly started observatory. 1888-89. Diagrams read off, the hourly readings being copied from the S. series into the other series.
MORMUGÁO (closed March 1889).	1886-87. Calculations completed. 1887-88. Diagrams not read off. A. P.	1887-88. Calculations completed. 1888-89. Calculations completed. A. P.
COCHIN . . .	1887-88. Calculations completed.	1888-89. Calculations completed. A. P.
COLOMBO . . .	1886-87. Calculations completed. 1887-88. Diagrams not read off. A. P.	1887-88. Calculations completed. 1888-89. Diagrams not read off. A. P.
GALLE . . .	1886-87. Calculations completed. 1887-88. Diagrams not read off. A. P.	1887-88. Calculations completed. 1888-89. Diagrams not read off. A. P.
TUTICORIN (started June 1888).	Newly started observatory. No diagrams read off.	1888-89. Calculations completed.
NEGAPATAM (closed April 1888).	1887-88. Calculations completed. A. P.	A. P.
MADRAS . . .	1885-86. Calculations completed. 1886-87. Diagrams read off, the hourly readings copied from the S. series into the other series, and the additions of hourly heights of each series ready. A. P.	1886-87. Calculations completed. 1887-88. Calculations completed. 1888-89. Diagrams not read off. A. P.
COCANADA . . .	1887-88. Calculations completed.	1888-89. Calculations completed. A. P.
KIDDERPORE . .	1886-87. Diagrams read off, the hourly readings copied from the S. series into the other series, and the additions of hourly heights of each series ready. A. P.	1886-87. Calculations completed. 1887-88. Calculations completed. 1888-89. Duplicates of S. series read off from diagrams. A. P.
CHITTAGONG . .	1887-88. Calculations completed.	1888-89. Calculations completed. A. P.
AKYAB . . .	1887-88. Calculations completed.	1888-89. Calculations completed. A. P.

State of the ordinary reductions of yearly tidal registrations, &c.—contd.

Tidal observatory.	State at end of September 1888.	State at end of September 1889.
Elephant Point (closed June 1888).	1886. Calculations completed. 1887. Calculations completed. 1887-88. Calculations completed. A. P.	A. P.
Rangoon . . .	1885-86. Calculations completed. 1886-87. Diagrams read off, the hourly readings copied from the S. series into the other series, and the additions of hourly heights of each series ready. A. P.	1886-87. Calculations completed. 1887-88. Calculations completed. 1888-89. Duplicate of S. series read off from diagrams. A. P.
Mergui (started March 1889).		Newly started observatory. No diagrams read off.
Port Blair . .	1885-86. Calculations completed. 1886-87. Calculations completed. A. P.	1887-88. Calculations completed. 1888-89. Diagrams not read off. A. P.

Values of the Tidal Constants, Aden, 1887-88.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1887-88 observations at Aden; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1887-88 observations.

Short Period Tides.

$A_0 = 5{\cdot}822$ feet.

S_1	H = R	·095	M_6	R	·006	Q_1	R	·147	T_2	R	·035
	$\kappa = \zeta$	169°·20		ζ	273°·18		ζ	36°·59		ζ	21°·00
S_2	H = R	·700		H	·006		H	·169		H	·035
	$\kappa = \zeta$	245°·89		κ	8°·62		κ	35°·86		κ	321°·19
S_4	H = R	·005	M_8	R	·001	L_2	R	·021	$(MS)_4$	R	·009
	$\kappa = \zeta$	326°·63		ζ	236°·31		ζ	303°·01		ζ	337°·33
S_6	H = R	·006		H	·001		H	·026		H	·009
	$\kappa = \zeta$	208°·86		κ	123°·57		κ	185°·24		κ	129°·14
S_8	H = R	·002	O_1	R	·579	N_2	R	·458	$(2SM)_2$	R	·021
	$\kappa = \zeta$	341°·57		ζ	125°·35		ζ	339°·18		ζ	251°·57
				H	·666		H	·446		H	·020
				κ	36°·55		κ	219°·07		κ	99°·75
M_1	R	·052	K_1	R	1·204	λ_2	R	...	$2N_2$	R	·091
	ζ	78°·69		ζ	150°·77		ζ	...		ζ	227°·72
	H	·030		H	1·307		H	...		H	·088
	κ	66°·27		κ	34°·88		κ	...		κ	195°·68
M_2	R	1·638	K_2	R	·167	ν_2	R	·101	$(M_2N)_4$	R	·035
	ζ	74°·08		ζ	288°·58		ζ	57°·86		ζ	55°·61
	H	1·594		H	·206		H	·098		H	·034
	κ	225°·89		κ	237°·64		κ	274°·84		κ	87°·31
M_3	R	·018	P_1	R	·388	μ_2	R	·078	$(M_2K_1)_3$	R	·032
	ζ	170°·91		ζ	282°·97		ζ	248°·05		ζ	300°·48
	H	·018		H	·388		H	·074		H	·033
	κ	218°·63		κ	32°·15		κ	191°·68		κ	336°·41
M_4	R	·008	J_1	R	·166	R_2	R	...	$(2M_2K_1)_3$	R	·006
	ζ	36°·72		ζ	252°·39		ζ	...		ζ	13°·80
	H	·008		H	·119		H	...		H	·006
	κ	340°·35		κ	44°·93		κ	...		κ	73°·31

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·055	117°·67	·050	29°·60
„ Fortnightly „	·021	192·90	·028	342·31
Luni-Solar „ „	·018	236·68	·018	84·87
Solar-Annual „	·416	4·47	·416	345·29
„ Semi-Annual „	·152	182·45	·152	144·10

Values of the Tidal Constants, Bhávnagar, 1888.

The following are the Amplitudes (R) and epochs (ζ) deduced from the 1888 observations at Bhávnagar; and also the *mean* values of the amplitudes (H) and of the epoch (κ) for each particular tide evaluated from the 1888 observations.

Short Period Tides.

$A_0 = 22{\cdot}586$ feet.

S_1	H = R =	·169	M_6	R =	·228	Q_1	R =	·215	T_2	R =	·462
	$\kappa = \zeta$ =	183°·05		ζ =	292°·21		ζ =	247°·53		ζ =	187°·26
S_2	H = R =	3·433		H =	·215		H =	·234		H =	·462
	$\kappa = \zeta$ =	175°·15		κ =	116°·08		κ =	87°·95		κ =	187°·90
S_4	H = R =	·132	M_8	R =	·030	L_2	R =	·678	$(MS)_4$	R =	·683
	$\kappa = \zeta$ =	222°·35		ζ =	324°·16		ζ =	105°·67		ζ =	255°·47
S_6	H = R =	·017		H =	·027		H =	·717		H =	·669
	$\kappa = \zeta$ =	259°·55		κ =	89°·32		κ =	137°·63		κ =	196°·76
S_8	H = R =	·010	O_1	R =	·904	N_2	R =	2·496	$(2SM)_2$	R =	·037
	$\kappa = \zeta$ =	194°·60		ζ =	320°·39		ζ =	97°·36		ζ =	287°·39
				H =	·983		H =	2·447		H =	·036
				κ =	83°·50		κ =	115°·95		κ =	346°·10
M_1	R =	·155	K_1	R =	2·190	λ_2	R =	...	$2N_2$	R =	·414
	ζ =	207°·89		ζ =	268°·76		ζ =	...		ζ =	329°·92
	H =	·098		H =	2·304		H =	...		H =	·406
	κ =	108°·09		κ =	90°·98		κ =	...		κ =	65°·81
M_2	R =	10·916	K_2	R =	·857	ν_2	R =	·705	$(M_2N)_4$	R =	·140
	ζ =	192°·61		ζ =	342°·57		ζ =	269°·45		ζ =	138°·67
	H =	10·704		H =	·986		H =	·691		H =	·135
	κ =	133°·90		κ =	167°·59		κ =	76°·54		κ =	98°·55
M_3	R =	·117	P_1	R =	·707	μ_2	R =	·356	$(M_2K_1)_3$	R =	·281
	ζ =	239°·57		ζ =	284°·40		ζ =	37°·14		ζ =	13°·71
	H =	·114		H =	·707		H =	·342		H =	·290
	κ =	331°·51		κ =	94°·02		κ =	279°·72		κ =	137°·22
M_4	R =	·958	J_1	R =	·209	R_2	R =	...	$(2M_2K_1)_3$	R =	·126
	ζ =	269°·86		ζ =	45°·08		ζ =	...		ζ =	287°·07
	H =	·922		H =	·224		H =	...		H =	·127
	κ =	152°·44		κ =	145°·95		κ =	...		κ =	347°·43

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·150	108°·54	·141	31°·24
,, Fortnightly ,, ...	·054	57·63	·065	292·69
Luni-Solar ,, ,, ...	·227	336·18	·223	34·89
Solar-Annual ,, ...	·094	166·88	·094	87·26
,, Semi-Annual ,, ...	·168	317·64	·168	158·40

Values of the Tidal Constants, Bombay, 1887.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1887 observations at Bombay; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1887 observations.

Short Period Tides.

$A_0 = 10{\cdot}210$ feet.

S_1	H = R =	·055	M_6	R =	·013	Q_1	R =	·128	T_2	R =	·138
	$\kappa = \zeta$ =	191°·93		ζ =	240°·32		ζ =	226°·62		ζ =	51°·68
S_2	H = R =	1·610		H =	·012		H =	·149		H =	·138
	$\kappa = \zeta$ =	1°·88		κ =	123°·50		κ =	52°·76		κ =	52°·06
S_4	H = R =	·011	M_8	R =	·005	L_2	R =	·025	$(MS)_4$	R =	·153
	$\kappa = \zeta$ =	283°·64		ζ =	310°·31		ζ =	34°·65		ζ =	186°·92
S_6	H = R =	·003		H =	·005		H =	·031		H =	·149
	$\kappa = \zeta$ =	173°·89		κ =	34°·56		κ =	250°·97		κ =	27°·98

Short Period Tides—contd.

A_0 = 10·102 feet.

S_8	H = H =	·002	O_1	R =	·563	N_2	R =	1·056	$(2SM)_2$	R =	·028
	κ = ζ =	149°·54		ζ =	26°·86		ζ =	305°·11		ζ =	325°·11
				H =	·653		H =	1·026		H =	·027
				κ =	46°·95		κ =	312° 22		κ =	124°·05
M_1	R =	·083	K_1	R =	1·277	λ_2	R =	...	$2N_2$	R =	·149
	ζ =	93°·96		ζ =	220°·79		ζ =	...		ζ =	115°·70
	H =	·048		H =	1·395		H =	...		H =	·145
	κ =	103°·01		κ =	45°·09		κ =	...		κ =	288°·86
M_2	R =	4·158	K_2	R =	·322	ν_2	R =	·304	$(M_2N)_4$	R =	.151
	ζ =	127°·60		ζ =	170°·83		ζ =	72°·91		ζ =	70°·95
	H =	4·040		H =	·402		H =	·295		H =	·143
	κ =	328°·66		κ =	0°·27		κ =	310°·32		κ =	279°·12
M_3	R =	·084	P_1	R =	·409	μ_2	R =	·231	$(M_2K_1)_3$	R =	·050
	ζ =	272°·59		ζ =	235°·59		ζ =	251°·63		ζ =	211°·09
	H =	·080		H =	·409		H =	·218		H =	·053
	κ =	34°·18		κ =	44°·96		κ =	293°·75		κ =	236°·45
M_4	R =	·130	J_1	R =	·082	R_2	R =	...	$(2M_2K_1)_3$	R =	·036
	ζ =	281°·80		ζ =	27°·25		ζ =	...		ζ =	195°·86
	H =	·122		H =	·093		H =	...		H =	·037
	κ =	323°·93		κ =	42°·17		κ =	...		κ =	53° 68

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·070	286° 93	·064	120° 88
„ Fortnightly „	·011	350 ·83	·015	331 ·70
Luni-Solar „ „	·021	273 ·55	·020	72 ·49
Solar-Annual „	·121	37 ·72	·121	318 ·34
„ Semi-Annual „	·205	345 ·96	·205	187 ·20

Values of the Tidal Constants, Bombay, 1888.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1888 observations at Bombay; and also the *mean* values of the amplitudes (H) and of the epochs (κ) or each particular tide evaluated from the 1888 observations.

Short Period Tides.

A_0 = 10·249 feet.

S_1	H = R =	·067	M_6	R =	·010	Q_1	R =	·160	T_2	R =	·239
	κ = ζ =	186°·74		ζ =	256°·41		ζ =	209°·50		ζ =	19°·07
S_2	H = R =	1·631		H =	·010		H =	·174		H =	·239
	κ = ζ =	2°·28		κ =	80° 43		κ =	50°·00		κ =	19°·71
S_4	H = R =	·010	M_8	R =	·005	L_2	R =	·098	$(MS)_4$	R =	·130
	κ = ζ =	305°·22		ζ =	263°·52		ζ =	310° 61		ζ =	78°·08
S_6	H = R =	·005		H =	·005		H =	·104		H =	·127
	κ = ζ =	158° 81		κ =	28°·88		κ =	342°·60		κ =	19°·42
S_8	H = R =	·001	O_1	R =	606	N_2	R =	1·055	$(2SM)_2$	R =	·044
	κ = ζ =	196°·70		ζ =	285°·59		ζ =	296°·78		ζ =	44°·91
				H =	·660		H =	1·035		H =	·043
				κ =	48°·76		κ =	315°·45		κ =	103°·57
M_1	R =	·085	K_1	R =	1·319	λ_2	R =	...	$2N_2$	R =	·184
	ζ =	137°·74		ζ =	222° 89		ζ =	...		ζ =	211°·43
	H =	·053		H =	1·388		H =	...		H =	·180
	κ =	37°·96		κ =	45°·11		κ =	...		κ =	307°·43
M_2	R =	4·150	K_2	R =	·371	ν_2	R =	·215	$(M_2N)_4$	R =	·066
	ζ =	28°·21		ζ =	168°·10		ζ =	105°·73		ζ =	5°·37
	H =	4·069		H =	·427		H =	·211		H =	·064
	κ =	329°·55		κ =	353°·13		κ =	272°·90		κ =	325°·37
M_3	R =	·078	P_1	R =	·417	μ_2	R =	·180	$(M_2K_1)_3$	R =	·025
	ζ =	299°·94		ζ =	236°·38		ζ =	64°·26		ζ =	299° 06
	H =	·076		H =	·417		H =	·173		H =	·026
	κ =	31°·95		κ =	46°·00		κ =	306°·94		κ =	62°·62
M_4	R =	·141	J_1	R =	·127	R_2	R =	...	$(2M_2K_1)_3$	R =	·046
	ζ =	76°·75		ζ =	323°·20		ζ =	...		ζ =	14°·91
	H =	·135		H =	·136		H =	...		H =	·046
	κ =	319°·43		κ =	64°·05		κ =	...		κ =	75°·37

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·036	97°·85	·034	20°·53
„ Fortnightly „ . . .	·059	62 ·45	·071	297 ·46
Luni-Solar „ „ . . .	·016	266 ·75	·016	325 ·41
Solar-Annual „ . . .	·079	50 ·11	·079	330 ·49
„ Semi-Annual „ . . .	·174	349 ·70	·174	190 ·46

VALUES OF THE TIDAL CONSTANTS, MORMUGÁO, 1887-88.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1888 observations at Mormugáo; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1887-88 observations.

Short Period Tides.

$A_0 = 5{\cdot}486$ feet.

S_1	H = R =	·046	M_6	R =	·015	Q_1	R =	·086	T_2	R =	·073
	κ = ζ =	181°·50		ζ =	7°·60		ζ =	182°·34		ζ =	69°·70
S_2	H = R =	·638		H =	·014		H =	·099		H =	·073
	κ = ζ =	330°·05		κ =	237° 94		κ =	45°·16		κ =	357°·21
S_4	H = R =	·009	M_8	R =	·014	L_2	R =	·061	$(MS)_4$	R =	·017
	κ = ζ =	86° 96		ζ =	322°·34		ζ =	247°·60		ζ =	192° 02
S_6	H = R =	·005		H =	·013		H =	·075		H =	·016
	κ = ζ =	114°·34		κ =	29° 47		κ =	342°·98		κ =	28°·80
S_8	H = R =	·001	O_1	R =	·455	N_2	R =	·446	$(2SM)_2$	R =	·007
	κ = ζ =	45°·00		ζ =	104° 12		ζ =	162°·95		ζ =	347°·13
				H =	·522		H =	·434		H =	·007
				κ =	47° 66		κ =	279°·00		κ =	150°·34
M_1	R =	·029	K_1	R =	·946	λ_2	R =	...	$2N_2$	R =	·054
	ζ =	201°·21		ζ =	147°·99		ζ =	...		ζ =	193° 49
	H =	·017		H =	1·027		H =	...		H =	·050
	κ =	31°·94		κ =	44°·76		κ =	...		κ =	228°·82
M_2	R =	1·870	K_2	R =	·153	ν_2	R =	·086	$(M_2N)_4$	R =	·072
	ζ =	102°·40		ζ =	341° 21		ζ =	219°·47		ζ =	51°·72
	H =	1·820		H =	·187		H =	·084		H =	·068
	κ =	299°·18		κ =	315° 57		κ =	335°·21		κ =	4°·55
M_3	R =	·019	P_1	R =	·300	μ_2	R =	·051	$(M_2K_1)_3$	R =	·015
	ζ =	354°·07		ζ =	308°·35		ζ =	214°·17		ζ =	66° 12
	H =	·018		H =	·300		H =	·048		H =	·016
	κ =	289°·25		κ =	44°·79		κ =	247° 73		κ =	159° 67
M_4	R =	·051	J_1	R =	·043	R_2	R =	...	$(2M_2K_1)_3$	R =	·007
	ζ =	328°·82		ζ =	100°·69		ζ =	...		ζ =	291°·95
	H =	·049		H =	·049		H =	...		H =	·008
	κ =	2°·38		κ =	74°·65		κ =	...		κ =	68°·74

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tides . . .	·054	25°·70	·049	106°·43
„ Fortnightly „ . . .	·020	23 ·94	·027	153 ·63
Luni-Solar „ „ . . .	·010	125 ·65	·0.0	288 ·86
Solar-Annual „ . . .	·356	303 ·89	·356	297 ·45
„ Semi-Annual „ . . .	·191	188 ·18	·191	175 ·30

Values of the Tidal Constants, Mormugáo, 1888-89.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1888-89 observations at Mormugáo; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1888-89 observations.

Short Period Tides.

A_0=5·451 feet.

S_1	H = R =	·050	M_6	R =	·007	Q_1	R =	·105	T_2	R =	·096
	κ = ζ =	184°·93		ζ =	151°·03		ζ =	218°·15		ζ =	25°·78
S_2	H = R =	·644		H =	·007		H =	·112		H =	·096
	κ = ζ =	329°·36		κ =	249°·18		κ =	56°·55		κ =	312°·50
S_4	H = R =	·010	M_8	R =	·013	L_2	R =	·050	$(MS)_4$	R =	·031
	κ = ζ =	76°·10		ζ =	12° 06		ζ =	46°·22		ζ =	126°·99
S_6	H = R =	·004		H =	·012		H =	·050		H =	·031
	κ = ζ =	101°·04		κ =	22°·91		κ =	309°·09		κ =	39°·70
S_8	H = R =	·004	O_1	R =	·487	N_2	R =	·447	$(2SM)_2$	R =	·011
	κ = ζ =	43°·92		ζ =	26°·11		ζ =	188°·07		ζ =	34°·12
				H =	·522		H =	·439		H =	·011
				κ =	47°·03		κ =	278°·27		κ =	121°·40
M_1	R =	·016	K_1	R =	·979	λ_2	R =	...	$2N_2$	R =	·063
	ζ =	25°·92		ζ =	148°·57		ζ =	...		ζ =	320°·81
	H =	011		H =	1·021		H =	...		H =	·062
	κ =	97°·64		κ =	44°·48		κ =	...		κ =	228°·49
M_2	R =	1·840	K_2	R =	·161	ν_2	R =	·140	$(M_2N)_4$	R =	·040
	ζ =	25°·09		ζ =	348°·57		ζ =	292°·06		ζ =	13°·96
	H =	1·809		H =	·182		H =	·137		H =	·039
	κ =	297°·80		κ =	320°·87		κ =	301°·90		κ =	16°·88
M_3	R =	·019	P_1	R =	·305	μ_2	R =	·066	$(M_2K_1)_3$	R =	·019
	ζ =	54°·78		ζ =	307°·80		ζ =	76°·84		ζ =	180°·92
	H =	·019		H =	·305		H =	·064		H =	·020
	κ =	283°·85		κ =	43°·50		κ =	262° 26		κ =	349°·54
M_4	R =	·050	J_1	R =	·053	R_2	R =	...	$(2M_2K_1)_3$	R =	·007
	ζ =	171°·87		ζ =	330°·19		ζ =	...		ζ =	139°·50
	H =	·049		H =	·056		H =	...		H =	·007
	κ =	357°·30		κ =	44°·50		κ =	...		κ =	69°·02

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·011	118°·0	·010	300°·58
„ Fortnightly „	·048	266·85	·056	317·72
Luni-Solar „ „	·025	218·25	·025	305·53
Solar-Annual „	·226	306·84	·226	301·14
„ Semi-Annual „	·128	150·98	·128	139·58

Values of the Tidal Constants, Cochin, 1888-89.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1888-89 observations at Cochin; and also the *mean* values of the amplitudes (H) and of the epochs (κ) or each particular tide evaluated from the 1888-89 observations.

Short Period Tides.

A_0=2·307 feet.

S_1	H = R =	·024	M_6	R =	·009	Q_1	R =	·078	T_2	R =	·030
	κ = ζ =	187°·83		ζ =	209°·91		ζ =	71°·99		ζ =	29°·89
S_2	H = R =	·259		H =	·009		H =	·084		H =	·030
	κ = ζ =	26°·88		κ =	79°·07		κ =	70°·55		κ =	6°·88
S_4	H = R =	·007	M_8	R =	·005	L_2	R =	·034	$(MS)_4$	R =	·021
	κ = ζ =	153°·82		ζ =	12°·80		ζ =	235°·08		ζ =	49°·53
S_6	H = R =	·005		H =	·005		H =	·035		H =	·020
	κ = ζ =	221°·99		κ =	318°·35		κ =	355°·33		κ =	125°·91

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Short Period Tides—contd.

A_0=2·307 feet.

S_8	H = R =	·002	O_1	R =	·283	N_2	R =	·163	$(2SM)_2$	R =	·003
	κ = ζ =	327°·27		ζ =	183°·55		ζ =	104°·59		ζ =	50°·71
				H =	·307		H =	·160		H =	·003
				κ =	58°·22		κ =	304°·86		κ =	334°·33
M_1	R =	·026	K_1	R =	·568	λ_2	R =	...	$2N_2$	R =	·015
	ζ =	117°·16		ζ =	206°·33		ζ =	...		ζ =	292°·74
	H =	·017		H =	·596		H =	...		H =	·015
	κ =	86°·67		κ =	52°·11		κ =	...		κ =	256°·90
M_2	R =	·736	K_2	R =	·073	ν_2	R =	·054	$(M_2N)_4$	R =	·028
	ζ =	256°·45		ζ =	149°·87		ζ =	256°·02		ζ =	230°·09
	H =	·722		H =	·083		H =	·053		H =	·027
	κ =	332°·84		κ =	21°·99		κ =	286°·74		κ =	146°·75
M_3	R =	·007	P_1	R =	·162	μ_2	R =	·006	$(M_2K_1)_3$	R =	·020
	ζ =	276°·71		ζ =	264°·68		ζ =	43°·67		ζ =	191°·66
	H =	·007		H =	·162		H =	·006		H =	·020
	κ =	211°·29		κ =	50°·65		κ =	196°·44		κ =	113°·83
M_4	R =	·024	J_1	R =	·045	R_2	R =	...	$(2M_2K_1)_3$	R =	·020
	ζ =	281°·65		ζ =	331°·95		ζ =	...		ζ =	162°·47
	H =	·024		H =	·048		H =	...		H =	·021
	κ =	74°·42		κ =	49°·78		κ =	...		κ =	109°·46

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·059	144°·71	·055	20°·82
„ Fortnightly „	·047	138·02	·056	285·07
Luni-Solar „ „	·027	11·90	·026	295·51
Solar-Annual „	·286	352·43	2·86	296·46
„ Semi-Annual „	·159	248·74	·159	136·80

VALUES OF THE TIDAL CONSTANTS, GALLE, 1887-88.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1887-88 observations at Galle; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1887-88 observations.

Short Period Tides.

A_0 = 2·606 feet.

S_1	H = R =	·011	M_6	R =	·002	Q_1	R =	·026	T_2	R =	·016
	κ = ζ =	34°·29		ζ =	161°·57		ζ =	122°·40		ζ =	191°·67
S_2	H = R =	·369		H =	·002		H =	·030		H =	·016
	κ = ζ =	92°·94		κ =	302°·84		κ =	91°·11		κ =	103°·36
S_4	H = R =	·003	M_8	R =	·001	L_2	R =	·024	$(MS)_4$	R =	·008
	κ = ζ =	241°·93		ζ =	190°·31		ζ =	112°·03		ζ =	69°·81
S_6	H = R =	·001		H =	·001		H =	·029		H =	·007
	κ = ζ =	26°·57		κ =	138°·67		κ =	25°·77		κ =	236°·91
S_8	H = R =	·001	O_1	R =	·043	N_2	R =	·061	$(2SM)_2$	R =	·007
	κ = ζ =	296°·57		ζ =	175°·57		ζ =	167°·02		ζ =	113°·31
				H =	·049		H =	·060		H =	·007
				κ =	73°·81		κ =	44°·58		κ =	306°·21
M_1	R =	·013	K_1	R =	·157	λ_2	R =	...	$2N_2$	R =	·009
	ζ =	352°·44		ζ =	106°·39		ζ =	...		ζ =	122°·22
	H =	·007		H =	·170		H =	...		H =	·009
	κ =	349°·16		κ =	18°·82		κ =	...		κ =	70°·24
M_2	R =	·538	K_2	R =	·094	ν_2	R =	·005	$(M_2N)_4$	R =	·015
	ζ =	247°·47		ζ =	84°·74		ζ =	255°·14		ζ =	205°·64
	H =	·524		H =	·115		H =	·005		H =	·014
	κ =	54°·56		κ =	90°·42		κ =	160°·33		κ =	250°·29
M_3	R =	·012	P_1	R =	·043	μ_2	R =	·021	$(M_2K_1)_3$	R =	·004
	ζ =	87°·16		ζ =	299°·73		ζ =	124°·75		ζ =	85°·60
	H =	·012		H =	·043		H =	·020		H =	·004
	κ =	157°·80		κ =	20°·42		κ =	98°·93		κ =	165°·12
M_4	R =	·015	J_1	R =	·012	R_2	R =	...	$(2M_2K_1)_3$	R =	·004
	ζ =	187°·33		ζ =	178°·54		ζ =	...		ζ =	312°·71
	H =	·014		H =	·013		H =	...		H =	·004
	κ =	161°·51		κ =	16°·93		κ =	...		κ =	14°·46

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·063	112°·96	·058	42°·49
„ Fortnightly „	·054	181·94	·073	12·56
Luni-Solar „	·029	19·54	·028	212·44
Solar-Annual „	·371	288·22	·371	297·53
„ Semi-Annual „	·096	106·73	·096	125·34

VALUES OF THE TIDAL CONSTANTS, COLOMBO, 1887-88.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1887-88 observations at Colombo; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1887-88 observations.

Short Period Tides.

A_0 = 2·199 feet.

S_1	H = R =	·006	M_6	R =	·004	Q_1	R =	·032	T_2	R =	·014
	κ = ζ =	358°·09		ζ =	225°·00		ζ =	10°·84		ζ =	147°·63
S_2	H = R =	·404		H =	·004		H =	·036		H =	·014
	κ = ζ =	92°·48		κ =	1°·97		κ =	86°·57		κ =	117°·48
S_4	H = R =	·006	M_8	R =	·001	L_2	R =	·023	$(MS)_4$	R =	·009
	κ = ζ =	218°·33		ζ =	164°·75		ζ =	162°·96		ζ =	71°·57
S_6	H = R =	·001		H =	·001		H =	·028		H =	·009
	κ = ζ =	148° 00		κ =	107°·37		κ =	27°·22		κ =	237° 22
S_8	H = R =	·000	O_1	R =	·080	N_2	R =	·077	$(2SM)_2$	R =	·005
	κ = ζ =	108°·44		ζ =	107°·59		ζ =	104° 15		ζ =	127°·35
				H =	·092		H =	·075		H =	·005
				κ =	62°·03		κ =	31°·09		κ =	321° 69
M_1	R =	·012	K_1	R =	·221	λ_2	R =	...	$2N_2$	R =	·015
	ζ =	22°·41		ζ =	176°·07		ζ =	...		ζ =	43°·35
	H =	·007		H =	·240		H =	...		H =	·015
	κ =	15°·35		κ =	30°·70		κ =	...		κ =	91°·58
M_2	R =	·610	K_2	R =	·093	ν_2	R =	·023	$(M_2N)_4$	R =	·013
	ζ =	241°·29		ζ =	200°·31		ζ =	196°·12		ζ =	213°·69
	H =	·593		H =	·115		H =	·022		H =	·013
	κ =	46°·95		κ =	90°·42		κ =	47°·53		κ =	306°·29
M_3	R =	·017	P_1	R =	·066	μ_2	R =	·017	$(M_2K_1)_3$	R =	·009
	ζ =	99° 64		ζ =	248°·88		ζ =	139°·80		ζ =	71°·57
	H =	·016		H =	·066		H =	·016		H =	·009
	κ =	168°·12		κ =	27° 72		κ =	111°·12		κ =	91°·86
M_4	R =	·019	J_1	R =	·020	R_2	R =	...	$(2M_2K_1)_3$	R =	·005
	ζ =	200°·04		ζ =	296°·30		ζ =	...		ζ =	292°·71
	H =	·018		H =	·022		H =	...		H =	·005
	κ =	171°·35		κ =	26°·24		κ =	...		κ =	49°·39

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·031	197°·57	·028	76°·28
„ Fortnightly „	·048	305 ·98	·066	22 ·76
Luni-Solar „	·026	86 ·04	·025	280 ·39
Solar-Annual „	·331	347 ·36	·331	298 ·52
„ Semi-Annual „	·105	214 ·33	·105	116 ·65

Values of the Tidal Constants, Tuticorin, 1888-89.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1888-89 observations at Tuticorin; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1888-89 observations.

Short Period Tides.

$A_0 = 2{\cdot}091$ feet.

S_1	H = R =	·034	M_6	R =	·014	Q_1	R =	·030	T_2	R =	...
	$\kappa = \zeta$ =	62°·98		ζ =	214°·95		ζ =	358°·30		ζ =	...
S_2	H = R =	·458		H =	·013		H =	·032		H =	...
	$\kappa = \zeta$ =	84°·90		κ =	8°·52		κ =	79°·64		κ =	...
S_4	H = R =	·005	M_8	R =	·006	L_2	R =	·027	$(MS)_4$	R =	·009
	$\kappa = \zeta$ =	227°·35		ζ =	339°·83		ζ =	322°·96		ζ =	92°·12
S_6	H = R =	·007		H =	·006		H =	·026		H =	·008
	$\kappa = \zeta$ =	180°·83		κ =	304°·58		κ =	63°·90		κ =	253°·31
S_8	H = R =	·005	O_1	R =	·168	N_2	R =	·084	$(2SM)_2$	R =	·005
	$\kappa = \zeta$ =	224°·09		ζ =	206°·14		ζ =	342°·51		ζ =	114°·62
				H =	·114		H =	·083		H =	·005
				κ =	48°·90		κ =	32°·27		κ =	303°·44
M_1	R =	·004	K_1	R =	·290	λ_2	R =	...	$2N_2$	R =	·005
	ζ =	289°·29		ζ =	54°·20		ζ =	...		ζ =	78°·06
	H =	·003		H =	·300		H =	...		H =	·005
	κ =	137°·47		κ =	26°·77		κ =	...		κ =	6°·39
M_2	R =	·665	K_2	R =	·116	ν_2	R =	·002	$(M_2N)_4$	R =	·019
	ζ =	232°·91		ζ =	319°·74		ζ =	287°·65		ζ =	214°·30
	H =	·656		H =	·128		H =	·002		H =	·019
	κ =	44°·10		κ =	85°·28		κ =	33°·40		κ =	75°·25
M_3	R =	·018	P_1	R =	·076	μ_2	R =	·019	$(M_2K_1)_3$	R =	·009
	ζ =	266°·48		ζ =	351°·14		ζ =	110°·34		ζ =	310°·60
	H =	·018		H =	·076		H =	·019		H =	·009
	κ =	163°·27		κ =	9°·97		κ =	92°·72		κ =	94°·36
M_4	R =	·025	J_1	R =	·020	R_2	R =	...	$(2M_2K_1)_3$	R =	·005
	ζ =	179°·51		ζ =	335°·21		ζ =	...		ζ =	343°·74
	H =	·024		H =	·021		H =	...		H =	·005
	κ =	161°·89		κ =	65°·05		κ =	...		κ =	353°·54

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·062	261°·33	·059	22°·75
„ Fortnightly „ . . .	·034	52 ·86	·039	358 ·52
Luni-Solar „ „ . . .	·013	159 ·21	·013	348 ·02
Solar-Annual „ . . .	·289	240 ·63	·289	311 ·80
„ Semi-Annual „ . . .	·241	289 ·61	·241	71 ·95

Values of the Tidal Constants, Madras, 1886-87.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1886-87 observations at Madras; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1886-87 observations.

Short Period Tides.

$A_0 = 2{\cdot}320$ feet.

S_1	H = R =	·078	M_6	R =	·013	Q_1	R =	·016	T_2	R =	·067
	$\kappa = \zeta$ =	147°·89		ζ =	321°·10		ζ =	27°·05		ζ =	294°·63
S_2	H = R =	·442		H =	·011		H =	·019		H =	·067
	$\kappa = \zeta$ =	286°·34		κ =	157°·75		κ =	87°·07		κ =	264°·22
S_4	H = R =	·002	M_8	R =	·003	L_2	R =	·093	$(MS)_4$	R =	·011
	$\kappa = \zeta$ =	272°·86		ζ =	33°·11		ζ =	230°·51		ζ =	231°·07
S_6	H = R =	·002		H =	·003		H =	·094		H =	·010
	$\kappa = \zeta$ =	141°·34		κ =	295°·30		κ =	275°·37		κ =	296°·62

Short Period Tides—contd.

$A_0 = 2{\cdot}320$ feet.

S_8	H =			O_1	R =	·088	N_2	R =	·190	$(2SM)_2$	R =	·012
	R =		·001		ζ =	114°·97		ζ =	326°·52		ζ =	176°·12
	κ =	ζ =	39°·29		H =	·107		H =	·183		H =	·012
					κ =	324°·97		κ =	242°·09		κ =	110°·57
M_1	R =		·020	K_1	R =	·251	λ_2	R =	...	$2N_2$	R =	·042
	ζ =		200°·42		ζ =	125°·65		ζ =	...		ζ =	119°·95
	H =		·014		H =	·281		H =	...		H =	·041
	κ =		302°·80		κ =	343°·29		κ =	...		κ =	245°·55
M_2	R =		1·055	K_2	R =	125	ν_2	R =	·122	$(M_2N)_4$	R =	·044
	ζ =		186°·14		ζ =	20°·15		ζ =	59°·47		ζ =	114°·13
	H =		1·019		H =	·163		H =	·118		H =	·041
	κ =		251°·69		κ =	276°·11		κ =	341°·31		κ =	95°·25
M_3	R =		·004	P_1	R =	0·70	μ_2	R =	·039	$(M_2K_1)_3$	R =	·004
	ζ =		295°·35		ζ =	205°·24		ζ =	22°·93		ζ =	279°·73
	H =		·004		H =	·070		H =	·037		H =	·004
	κ =		33°·67		κ =	343°·84		κ =	154°·02		κ =	202°·92
M_4	R =		·008	J_1	R =	·012	R_2	R =	...	$(2M_2K_1)_3$	R =	·003
	ζ =		116°·90		ζ =	243°·86		ζ =	...		ζ =	120°·6
	H =		·008		H =	·014		H =	...		H =	·005
	κ =		247°·99		κ =	249°·39		κ =	..		κ =	34°·1 3

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·006	314°·92	·005	104°·90
„ Fortnightly „	·036	250·28	·055	75·83
Luni-Solar „ „	·006	201·15	·006	135·60
Solar-Annual „	·491	249·97	·491	201·37
„ Semi-Annual „	·363	225·83	·363	128·63

Values of the Tidal Constants, Madras, 1887-88.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1887-88 observations at Madras; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1887-88 observations.

Short Period Tides.

$A_0 = 2{\cdot}266$ feet.

S_1	H =			M_6	R =	·004	Q_1	R =	·011	T_2	R =	·036
	R =		·005		ζ =	39°·40		ζ =	3°·18		ζ =	346°·43
	κ =	ζ =	353°·16		H =	004		H =	·013		H =	·036
S_2	H =				κ =	176°·45		κ =	78°·95		κ =	316°·28
	R =		·393	M_8	R =	·003	L_2	R =	·016	$(MS)_4$	R =	·001
	κ =	ζ =	291°·44		ζ =	223°·26		ζ =	88°·92		ζ =	173°·66
S_4	H =				H =	·003		H =	·020		H =	·001
	R =		·003		κ =	166°·00		κ =	313°·20		κ =	339°·34
	κ =	ζ =	263°·42	O_1	R =	·077	N_2	R =	·244	$(2SM)_2$	R =	·023
S_6	H =				ζ =	25°·27		ζ =	320°·79		ζ =	53°·58
	R =		·001		H =	·089		H =	·237		H =	·022
	κ =	ζ =	201°·80		κ =	339°·74		κ =	247°·77		κ =	247°·90
S_8	H =			K_1	R =	·257	λ_2	R =	...	$2N_2$	R =	·039
	R =		·000		ζ =	135°·98		ζ =	...		ζ =	173°·32
	κ =	ζ =	243°·44		H =	·280		H =	...		H =	·038
					κ =	350°·62		κ =	...		κ =	221°·60
M^1	R =		·022	K_2	R =	·087	ν_2	R =	055	$(M_2N)_4$	R =	·031
	ζ =		1°·03		ζ =	28°·23		ζ =	55°·84		ζ =	82°·54
	H =		·013		H =	108		H =	·053		H =	·029
	κ =		353°·99		κ =	278°·34		κ =	267°·30		κ =	175°·20
M_2	R =		·977	P_1	R =	·084	μ_2	R =	·051	$(M_2K_1)_3$	R =	·013
	ζ =		96°·77		ζ =	217°·79		ζ =	230°·27		ζ =	292°·31
	H =		·950		H =	·084		H =	·049		H =	·014
	κ =		262°·45		κ =	356°·63		κ =	201°·64		κ =	312°·63
M_3	R =		·004	J_1	R =	·026	R_2	R =	...	$(2M_2K_1)_3$	R =	·004
	ζ =		321°·84		ζ =	246°·15		ζ =	...		ζ =	305°·54
	H =		·004		H =	·029		H =	...		H =	·004
	κ =		30°·37		κ =	336°·07		κ =	...		κ =	62°·27
M_4	R =		·003									
	ζ =		265°·76									
	H =		·003									
	κ =		237°·13									

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·025	69°·70	·023	308°·39
„ Fortnightly „	·032	241·44	·044	318·19
Luni-Solar „ „	·004	287·39	·004	121·71
Solar-Annual „	·286	271·67	·286	222·83
„ Semi-Annual „	·307	203·16	·307	105·48

VALUES OF THE TIDAL CONSTANTS, COCANADA, 1888-89.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1888-89 observations at Cocanada; and also *mean* values of the amplitudes (H) and of the epoch (κ) for each particular tide evaluated from the 1888-89 observations.

Short Period Tides.

$A_0 = 5{\cdot}154$ feet.

S_1	H = R =	·034	M_6	R =	·018	Q_1	R =	·002	T_2	R =	·087
	κ = ζ =	82°·47		ζ =	15°·56		ζ =	130°·24		ζ =	346°·66
S_2	H = R =	·642		H =	·017		H =	·002		H =	·087
	κ = ζ =	287°·43		κ =	98°·22		κ =	113°·10		κ =	257°·62
S_4	H = R =	·008	M_8	R =	·001	L_2	R =	·067	$(MS)_4$	R =	·027
	κ = ζ =	131°·58		ζ =	328°·00		ζ =	162°·47		ζ =	235°·58
S_6	H = R =	·003		H =	·001		H =	·066		H =	·027
	κ = ζ =	185°·19		κ =	318°·20		κ =	255°·89		κ =	143°·13
S_8	H = R =	·003	O_1	R =	·129	N_2	R =	·322	$(2SM)_2$	R =	·020
	κ = ζ =	81°·12		ζ =	331°·60		ζ =	358°·02		ζ =	98°·21
				H =	·138		H =	·316		H =	·020
				κ =	332°·65		κ =	247°·39		κ =	190°·66
M_1	R =	0·26	K_1	R =	·333	λ_2	R =	...	$2N_2$	R =	·041
	ζ =	94°·65		ζ =	68°·41		ζ =	...		ζ =	335°·20
	H =	·018		H =	·347		H =	...		H =	·041
	κ =	345°·08		κ =	339°·03		κ =	...		κ =	206°·38
M_2	R =	1·551	K_2	R =	·143	ν_2	R =	·107	$(M_2N)_4$	R =	·057
	ζ =	346°·18		ζ =	280°·36		ζ =	94°·33		ζ =	259°·76
	H =	1·525		H =	·161		H =	·105		H =	·055
	κ =	253°·74		κ =	282°·07		κ =	289°·52		κ =	56°·68
M_3	R =	·007	P_1	R =	·100	μ_2	R =	·025	$(M_2K_1)_3$	R =	·016
	ζ =	336°·68		ζ =	262°·07		ζ =	144°·08		ζ =	295°·24
	H =	·006		H =	·100		H =	·024		H =	·017
	κ =	18°·01		κ =	343°·00		κ =	319°·18		κ =	114°·42
M_4	R =	·033	J_1	R =	·033	R_2	R =	...	$(2M_2K_1)_3$	R =	·009
	ζ =	290°·00		ζ =	86°·51		ζ =	...		ζ =	52°·60
	H =	·032		H =	·035		H =	...		H =	·009
	κ =	105°·10		κ =	11°·20		κ =	...		κ =	317°·08

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·094	313°·50	·089	331°·68
„ Fortnightly „	·072	304·58	·084	30·03
Luni-Solar „ „	·062	249·78	·061	342·22
Solar-Annual „	·583	196·30	·583	205·36
„ Semi-Annual „	·403	93·94	·403	112·06

Values of the Tidal Constants, Kidderpore, 1886-87.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1886-87 observations at Kidderpore; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1886-87 observations.

Short Period Tides.

$A_0 = 11{\cdot}383$ feet.

S_1	H = R =	·082	M_6	R =	·159	Q_1	R =	·009	T_2	R =	·127
	κ = ζ =	196°·91		ζ =	110°·16		ζ =	11°·19		ζ =	166°·17
S_2	H = R =	1·482		H =	·144		H =	·011		H =	·127
	κ = ζ =	98°·21		κ =	324°·11		κ =	349°·45		κ =	87°·49
S_4	H = R =	·093	M_8	R =	·080	L_2	R =	·201	$(MS)_4$	R =	·673
	κ = ζ =	107°·99		ζ =	111°·24		ζ =	215°·18		ζ =	130°·25
S_6	H = R =	·005		H =	·070		H =	·210		H =	·651
	κ = ζ =	40°·97		κ =	276°·51		κ =	65°·45		κ =	81°·57
S_8	H = R =	·003	O_1	R =	·161	N_2	R =	·672	$(2SM)_2$	R =	·092
	κ = ζ =	297°·47		ζ =	334°·52		ζ =	163°·38		ζ =	328°·48
				H =	·194		H =	·649		H =	·089
				κ =	22°·65		κ =	44°·84		κ =	17°·17
M_1	R =	·058	K_1	R =	·343	λ_2	R =	...	$2N_2$	R =	·061
	ζ =	126°·23		ζ =	148°·67		ζ =	...		ζ =	225°·47
	H =	·039		H =	·384		H =	...		H =	·059
	κ =	354°·68		κ =	54°·17		κ =	...		κ =	37°·06
M_2	R =	3·643	K_2	R =	·347	ν_2	R =	·192	$(M_2N)_4$	R =	·157
	ζ =	106°·74		ζ =	104°·51		ζ =	29°·31		ζ =	42°·42
	H =	3·521		H =	·451		H =	·185		H =	·146
	κ =	58°·06		κ =	96°·23		κ =	2°·68		κ =	235°·19
M_3	R =	·059	P_1	R =	·136	μ_2	R =	·218	$(M_2K_1)_3$	R =	·114
	ζ =	207°·60		ζ =	309°·89		ζ =	300°·43		ζ =	164°·16
	H =	·056		H =	·136		H =	·203		H =	·123
	κ =	314°·58		κ =	40°·22		κ =	203°·07		κ =	20°·98
M_4	R =	·764	J_1	R =	·004	R_2	R =	...	$(2M_2K_1)_3$	R =	·027
	ζ =	136°·98		ζ =	300°·96		ζ =	...		ζ =	265°·02
	H =	·714		H =	·004		H =	...		H =	·028
	κ =	39°·61		κ =	274°·02		κ =	...		κ =	262°·16

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·321	283°·23	·287	353°·10
„ Fortnightly „ . . .	·174	344 ·15	·263	19 ·21
Luni-Solar „ „ . . .	1·012	352 ·05	·979	40 ·73
Solar-Annual „ . . .	3·114	163 ·15	3·114	162 ·83
„ Semi-Annual „ . . .	1·092	345 ·93	1·092	345 ·27

Values of the Tidal Constants, Kidderpore, 1887-88.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1887-88 observations at Kidderpore; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1887-88 observations.

Short Period Tides.

$A_0 = 11{\cdot}080$ feet.

S_1	H = R =	·077	M_6	R =	·169	Q_1	R =	·024	T_2	R =	·046
	κ = ζ =	208° 00		ζ =	168°·72		ζ =	14°·74		ζ =	254°·69
S_2	H = R =	1·490		H =	·156		H =	·027		H =	·046
	κ = ζ =	100°·51		κ =	323°·14		κ =	8°·57		κ =	176°·27

Short Period Tides—contd.

A_0=11·080 feet.

S_4	H = R =	·093	M_8	R =	·082	L_2	R =	·249	$(MS)_4$	R =	·671
	κ = ζ =	114°·01		ζ =	70°·79		ζ =	38°·19		ζ =	30°·90
S_6	H = R =	·004		H =	·073		H =	·304		H =	·653
	κ = ζ =	70°·64		κ =	276° 67		κ =	65°·84		κ =	82°·38
S_8	H = R =	·002	O_1	R =	·180	N_2	R =	·664	$(2SM)_2$	R =	082
	κ = ζ =	255°·38		ζ =	226°·00		ζ =	149°·09		ζ =	77°·98
				H =	·206		H =	·646		H =	·079
				κ =	18°·41		κ =	41°·97		κ =	26°·51
M_1	R =	·053	K_1	R =	·353	λ_2	R =	...	$2N_2$	R =	·103
	ζ =	270° 33		ζ =	147°·95		ζ =	...		ζ =	287°·13
	H =	·030		H =	·383		H =	...		H =	·100
	κ =	28°·72		κ =	50°·56		κ =	...		κ =	21°·43
M_2	R =	3·667	K_2	R =	·387	ν_2	R =	·137	$(M_2N)_4$	R =	·111
	ζ =	6°·52		ζ =	112°·02		ζ =	125°·60		ζ =	313°·09
	H =	3·568		H =	·474		H =	·133		H =	·105
	κ =	57°·99		κ =	98°·06		κ =	28°·59		κ =	257°·44
M_3	R =	·058	P_1	R =	·151	μ_2	R =	·244	$(M_2K_1)_3$	R =	·139
	ζ =	233°·70		ζ =	315°·46		ζ =	88°·05		ζ =	78°·01
	H =	·055		H =	·151		H =	·231		H =	·147
	κ =	310°·91		κ =	46°·03		κ =	190°·99		κ =	32°·09
M_4	R =	·776	J_1	R =	·023	R_2	R =	...	$(2M_2K_1)_3$	R =	·032
	ζ =	296°·22		ζ =	293°·36		ζ =	....		ζ =	86°·65
	H =	·735		H =	·026		H =	...		H =	·033
	κ =	39°·16		κ =	351°·01		κ =	...		κ =	286°·98

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	0·275	201°·21	0·251	359°·79
„ Fortnightly „ . . .	0·193	86·72	0.260	13·37
Luni-Solar „ „ . . .	0·932	97·19	0·907	45·72
Solar-Annual „ . . .	2·874	149·57	2·874	149·00
„ Semi-Annual „ . . .	0·711	338·35	0·711	337·21

VALUES OF THE TIDAL CONSTANTS, CHITTAGONG, 1888-89.

The following amplitudes (R) and epochs (ζ) deduced from the 1888-89 observations at Chittagong; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1888-89 observations:—

Short Period Tides.

A_0= 7·923 feet.

S_1	H = R =	·072	M_6	R =	·129	Q_1	R =	·020	T_2	R =	·133
	κ = ζ =	116°·28		ζ =	326°·79		ζ =	125°·94		ζ =	318°·80
S_2	H = R =	1·584		H =	·124		H =	·021		H =	·133
	κ = ζ =	68° 46		κ =	190°·55		κ =	55°·02		κ =	164°·75
S_4	H = R =	·056	M_8	R =	·030	L_2	R =	·369	$(MS)_4$	R =	·353
	κ = ζ =	57°·51		ζ =	184°·14		ζ =	343°·56		ζ =	307°·76
S_6	H = R =	·006		H =	·029		H =	·345		H =	·348
	κ = ζ =	135°·00		κ =	122°·48		κ =	39°·71		κ =	22°·35
S_8	H = R =	·004	O_1	R =	·271	N_2	R =	·859	$(2SM)_2$	R =	·135
	κ = ζ =	154° 89		ζ =	268°·52		ζ =	123°·08		ζ =	21°·12
				H =	·287		H =	·847		H =	·133
				κ =	10°·79		κ =	24°·48		κ =	306°·54
M_1	R =	·067	K_1	R =	·579	λ_2	R =	...	$2N_2$	R =	·214
	ζ =	285°·08		ζ =	45°·40		ζ =	...		ζ =	252°·20
	H =	·048		H =	·599		H =	...		H =	·211
	κ =	85°·37		κ =	21°·87		κ =	...		κ =	340°·41
M_2	R =	4·490	K_2	R =	·352	ν_2	R =	·119	$(M_2N)_4$	R =	·172
	ζ =	320°·53		ζ =	294°·97		ζ =	55°·08		ζ =	261°·47
	H =	4·424		H =	·389		H =	·117		H =	·167
	κ =	35°·12		κ =	68°·30		κ =	19°·39		κ =	237°·45

Short Period Tides—contd.

A_0 = 7·923 feet.

M_3	R =	·041	P_1	R =	·188	μ_2	R =	·313	$(M_2K_1)_3$	R =	·038
	ζ =	93°·47		ζ =	16°·39		ζ =	47°·25		ζ =	275°·85
	H =	·040		H =	·188		H =	·304		H =	·039
	κ =	205°·35		κ =	31°·32		κ =	196°·43		κ =	326°·90
M_4	R =	·415	J_1	R =	·017	R_2	R =	...	$(2M_2K_1)_3$	R =	·061
	ζ =	191°·93		ζ =	232°·24		ζ =	...		ζ =	107°·15
	H =	·403		H =	·018		H =	...		H =	·061
	κ =	341°·10		κ =	17°·75		κ =	...		κ =	279°·85

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·242	197°·94	·230	11°·13
„ Fortnightly „	·120	332·03	·136	22·07
Luni-Solar „ „	·457	114·20	·450	39·61
Solar-Annual „	1·637	57·54	1·637	132·62
„ Semi-Annual „	·206	127·26	·206	277·41

Values of the Tidal Constants, Akyab, 1888-89.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1888-89 observations at Akyab; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1888-89 observations.

Short Period Tides.

A_0 = 7·430 feet.

S_1	H = R =	·042	M_6	R =	·024	Q_1	R =	·007	T_2	R =	·020
	κ = ζ =	91°·23		ζ =	2°·63		ζ =	108°·70		ζ =	181°·13
S_2	H = R =	1·126		H =	·023		H =	·007		H =	·020
	κ = ζ =	308°·79		κ =	114°·72		κ =	33°·94		κ =	54°·69
S_4	H = R =	·007	M_8	R =	·007	L_2	R =	·120	$(MS)_4$	R =	·016
	κ = ζ =	210°·43		ζ =	340°·91		ζ =	262°·12		ζ =	215°·40
S_6	H = R =	·002		H =	·006		H =	·114		H =	·015
	κ = ζ =	55°·31		κ =	130°·36		κ =	274°·82		κ =	252°·77
S_8	H = R =	·001	O_1	R =	·173	N_2	R =	·514	$(2SM)_2$	R =	·031
	κ = ζ =	108°·44		ζ =	244°·03		ζ =	39°·86		ζ =	233°·02
				H =	·183		H =	·506		H =	·030
				κ =	336°·60		κ =	269°·90		κ =	195°·65
M_1	R =	·038	K_1	R =	·434	λ_2	R =	...	$2N_2$	R =	·079
	ζ =	243°·98		ζ =	34°·52		ζ =	...		ζ =	162°·10
	H =	·027		H =	·450		H =	...		H =	·078
	κ =	22°·87		κ =	343°·45		κ =	...		κ =	224°·80
M_2	R =	2·593	K_2	R =	·283	ν_2	R =	·071	$(M_2N)_4$	R =	·098
	ζ =	240°·21		ζ =	231°·20		ζ =	78°·28		ζ =	224°·18
	H =	2·553		H =	·316		H =	·070		H =	·095
	κ =	277°·58		κ =	309°·49		κ =	322°·27		κ =	131°·58
M_3	R =	·016	P_1	R =	·142	μ_2	R =	·028	$(M_2K_1)_3$	R =	·032
	ζ =	317°·40		ζ =	299°·20		ζ =	269°·38		ζ =	18°·44
	H =	·015		H =	·142		H =	·027		H =	·032
	κ =	13°·44		κ =	341°·72		κ =	344°·10		κ =	4°·73
M_4	R =	·005	J_1	R =	·025	R_2	R =	...	$(2M_2K_1)_3$	R =	·010
	ζ =	208°·14		ζ =	192°·65		ζ =	...		ζ =	275°·14
	H =	·005		H =	·026		H =	...		H =	·010
	κ =	282°·87		κ =	304°·77		κ =	...		κ =	40°·94

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·074	175°·40	·070	342°·73
„ Fortnightly „	·069	328 ·22	·079	0 ·44
Luni-Solar „ „	·027	358 ·69	·027	321 ·32
Solar-Annual „	·980	95 ·98	·980	143 ·45
„ Semi-Annual „	·184	95 ·63	·184	190 ·58

Values of the Tidal Constants, Rangoon, 1886-87.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1886-87 observations at Rangoon; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1886-87 observations.

Short Period Tides.

A_0 = 10·631 feet.

S_1	H = R =	·098	M_6	R =	·210	Q_1	R =	·025	T_2	R =	·135
	κ = ζ =	121°·88		ζ =	142°·35		ζ =	353°·18		ζ =	178°·11
S_2	H = R =	2·068		H =	·189		H =	·031		H =	·135
	κ = ζ =	170°·84		κ =	94°·05		κ =	59°·13		κ =	120°·15
S_4	H = R =	·083	M_8	P =	·093	L_2	R =	·591	$(MS)_4$	R =	·436
	κ = ζ =	256°·96		ζ =	56°·95		ζ =	50°·50		ζ =	113°·31
S_6	H = R =	·012		H =	·081		H =	·611		H =	·421
	κ = ζ =	50°·88		κ =	112°·55		κ =	138°·85		κ =	217°·21
S_8	H = R =	·005	O_1	R =	·246	N_2	R =	1·080	$(2SM)_2$	R =	·199
	κ = ζ =	122°·23		ζ =	165°·63		ζ =	153° 55		ζ =	166°·80
				H =	·298		H =	1·044		H =	·192
				κ =	26°·79		κ =	102°·23		κ =	62°·90
M_1	R =	·031	K_1	R =	·586	λ_2	R =	...	$2N_2$	R =	·057
	ζ =	239°·57		ζ =	151°·96		ζ =	...		ζ =	322°·50
	H =	·022		H =	·655		H =	...		H =	·055
	κ =	2°·97		κ =	36°·91		κ =	...		κ =	115°·97
M_2	R =	5·792	K_2	R =	·590	ν_2	R =	·244	$(M_2N)_4$	R =	·224
	ζ =	29°·96		ζ =	227°·07		ζ =	250°·46		ζ =	28°·11
	H =	5·597		H =	·769		H =	·236		H =	·209
	κ =	133°·86		κ =	177°·68		κ =	254°·30		κ =	80°·69
M_3	R =	·051	P_1	R =	·142	μ_2	R =	·636	$(M_2K_1)_3$	R =	·180
	ζ =	201°·95		ζ =	321°·23		ζ =	78°·72		ζ =	101°·53
	H =	·049		H =	·142		H =	·594		H =	·194
	κ =	357°·80		κ =	72°·28		κ =	286°·52		κ =	90°·38
M_4	R =	·473	J_1	R =	·019	R_2	R =	...	$(2M_2K_1)_3$	R =	·105
	ζ =	331°·50		ζ =	94°·51		ζ =	...		ζ =	97°·72
	H =	·441		H =	·023		H =	...		H =	·110
	κ =	179°·30		κ =	132°·47		κ =	...		κ =	60°·57

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·197	208°·01	·176	3°·22
„ Fortnightly „	·216	186·00	·328	27·57
Luni-Solar „ „	·506	149·89	·489	45·99
Solar-Annual „	1·344	175·01	1·344	153·96
„ Semi-Annual „	·099	30·62	·099	348·52

Values of the Tidal Constants, Rangoon 1887-88.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1887-88 observations at Rangoon; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1887-88 observations.

Short Period Tides.

$A_0 = 10{\cdot}418$ feet.

S_1	H = R =	·111	M_6	R =	·240	Q_1	R =	·036	T_2	R =	·245
	$\kappa = \zeta$ =	119°·64		ζ =	197°·26		ζ =	356°·04		ζ =	228°·33
S_2	H = R =	2·048		H =	·221		H =	·042		H =	·245
	$\kappa = \zeta$ =	172°·56		κ =	89°·40		κ =	77°·63		κ =	170°·63
S_4	H = R =	·089	M_8	R =	·113	L_2	R =	·450	$(MS)_4$	R =	·419
	$\kappa = \zeta$ =	260°·31		ζ =	8°·35		ζ =	239°·75		ζ =	12°·68
S_6	H = R =	·015		H =	·102		H =	·551		H =	·408
	$\kappa = \zeta$ =	45°·27		κ =	104°·53		κ =	146°·32		κ =	216°·72
S_8	H = R =	·001	O_1	R =	·253	N_2	R =	1·103	$(2SM)_2$	R =	·194
	$\kappa = \zeta$ =	78°·69		ζ =	65°·09		ζ =	156°·28		ζ =	263°·42
				H =	·291		H =	1·073		H =	·189
				κ =	30°·62		κ =	116°·39		κ =	59°·37
M_1	R =	·069	K_1	R =	·628	λ_2	R =	...	$2N_2$	R =	·060
	ζ =	74°·25		ζ =	153°·53		ζ =	...		ζ =	52°·92
	H =	·040		H =	·682		H =	...		H =	·059
	κ =	87°·83		κ =	35°·55		κ =	...		κ =	129°·09
M_2	R =	5·984	K_2	R =	·463	ν_2	R =	·305	$(M_2N)_4$	R =	·172
	ζ =	288°·89		ζ =	225°·51		ζ =	214°·02		ζ =	245°·93
	H =	5·821		H =	·570		H =	·297		H =	·163
	κ =	132°·94		κ =	170°·38		κ =	147°·48		κ =	50°·69
M_3	R =	·069	P_1	R =	·178	μ_2	R =	·511	$(M_2K_1)_3$	R =	·123
	ζ =	224°·46		ζ =	300°·59		ζ =	243°·97		ζ =	19°·94
	H =	·066		H =	·178		H =	·483		H =	·130
	κ =	350°·53		κ =	51°·88		κ =	292°·07		κ =	106°·00
M_4	R =	·460	J_1	R =	·020	R_2	R =	...	$(2M_2K_1)_3$	R =	·117
	ζ =	123°·26		ζ =	310°·83		ζ =	...		ζ =	247°·20
	H =	·436		H =	·022		H =	...		H =	·121
	κ =	171°·35		κ =	73°·28		κ =	...		κ =	53°·28

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·180	119°·84	·164	3°·77
„ Fortnightly „	·108	317·79	·147	50·79
Luni-Solar „ „	·548	252·55	·533	48·50
Solar-Annual „	1·189	164·20	1·189	142·91
„ Semi-Annual „	·120	66·93	·120	24·36

Values of the Tidal Constants, Port Blair, 1887-88.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1887-88 observations at Port Blair; and also the *mean* values of the amplitudes (H) and of the epoch (κ) for each particular tide evaluated from the 1887-88 observations.

Short Period Tides.

$A_0 = 4{\cdot}709$ feet.

S_1	H = R =	·022	M_6	R =	·007	Q_1	R =	·010	T_2	R =	·022
	$\kappa = \zeta$ =	56°·60		ζ =	207°·44		ζ =	240°·11		ζ =	84°·64
S_2	H = R =	·914		H =	·006		H =	·011		H =	·022
	$\kappa = \zeta$ =	321°·92		κ =	114°·58		κ =	238°·50		κ =	338°·63
S_4	H = R =	·007	M_8	R =	·003	L_2	R =	·092	$(MS)_4$	R =	·021
	$\kappa = \zeta$ =	220°·14		ζ =	351°·87		ζ =	223°·93		ζ =	108°·71
S_6	H = R =	·002		H =	·003		H =	·112		H =	·020
	$\kappa = \zeta$ =	203°·96		κ =	348°·06		κ =	293°·50		κ =	197°·76

Short Period Tides—contd.

A_0 = 2·909 feet.

S_8	H = R =	·002	O_1	R =	·140	N_2	R =	·410	$(2SM)_2$	R =	·019
	κ = ζ =	71°·57		ζ =	143°·53		ζ =	354°·17		ζ =	244°·27
				H =	·160		H =	·399		H =	·018
				κ =	306°·16		κ =	278°·97		κ =	155°·22
M_1	R =	·041	K_1	R =	·359	λ_2	R =	...	$2N_2$	R =	·044
	ζ =	209°·80		ζ =	41°·88		ζ =	...		ζ =	123°·54
	H =	·024		H =	·388		H =	...		H =	·043
	κ =	348°·45		κ =	331°·92		κ =	...		κ =	244°·10
M_2	R =	1·963	K_2	R =	·284	ν_2	R =	·051	$(M_2N)_4$	R =	·034
	ζ =	196°·99		ζ =	273°·72		ζ =	244°·45		ζ =	193°·09
	H =	1·911		H =	·346		H =	·050		H =	·032
	κ =	286°·04		κ =	314°·60		κ =	228°·30		κ =	206°·94
M_3	R =	·004	P_1	R =	·141	μ_2	R =	·073	$(M_2K_1)_3$	R =	·020
	ζ =	286°·86		ζ =	272°·58		ζ =	135°·34		ζ =	295°·76
	H =	·003		H =	·141		H =	·069		H =	·021
	κ =	60°·43		κ =	335°·56		κ =	313°·43		κ =	314°·84
M_4	R =	·023	J_1	R =	·021	R_2	R =	...	$(2M_2K_1)_3$	R =	·007
	ζ =	315°·93		ζ =	210°·96		ζ =	...		ζ =	299°·95
	H =	·022		H =	·024		H =	...		H =	·007
	κ =	134°·02		κ =	301°·63		κ =	...		κ =	188°·01

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·030	229°·93	·027	34°·18
„ Fortnightly „	·047	49·01	·063	352·80
Luni-Solar „ „	·037	106·32	·036	17·27
Solar-Annual „	·203	145·92	·203	172·94
„ Semi-Annual „	·136	117·70	·136	171·73

The Tide Tables.

In addition to the computations already mentioned, the usual work was done in connection with the next issue of Tide Tables which will contain the predicted heights and times of every high and low water at 30 Ports during the year 1890 and the month of January 1891. The combined volume will contain the predictions for 29 Ports, and those for the remaining Port—Prince's Dock, Bombay—will be published in a separate pamphlet, as the observations for the year 1888-89 were only completed on the 28th September. The values of the constants for 29 Ports were sent as usual to Mr. Roberts for use in the Tide Predicter, and those for Prince's Dock, Bombay, will be forwarded on the completion of the computations of the first year's observations. No change has been made in the methods used in calculating the data for the predictions for open coast and riverain ports, as those alluded to on page XVII of the last Annual Report have been found to answer remarkably well.

All the prefaces for the next issue of the Tide Tables were prepared by Colonel Rogers, R.E., while he was in charge of the party.

The free distribution of Tide Tables carried on in previous years was considerably restricted under the orders of the Government of India, and in consequence, a large amount of extra work was done in making enquiries, considering claims, answering objections, drawing up statements, and submitting monthly sale accounts to the Comptroller, India Treasuries.

The demand for Tide Tables has been steadily increasing year by year, and this year it necessitated, for the first time, the issue of a second edition of the tables in pamphlet form for Bombay and Rangoon, within a week of the receipt from London of the first edition. The second edition was most promptly photozincographed at Calcutta by Colonel J. Waterhouse, S.C., Assistant Surveyor-General, in charge of the Photographic Office, which not only saved time, but ensured accuracy.

The final datum for Tuticorin tidal observatory has been determined from one year's observations and is given below: this information was given for 28 other stations in the three preceding reports.

Name of Tidal observatory.	Datum to which the heights in the Tide-Tables for 1890 are referred.	Datum below Mean Sea-level.
		Feet.
Tuticorin	Indian Spring low-water mark	1·528

The usual four tabular statements are appended showing the percentage and amount of errors in the predicted times and heights of high and low water for the year 1888, as determined by comparison of the values entered in the Tide Tables for that year with the actual values obtained by measurements from the tidal diagrams of 16 stations, and in the case of Moulmein from personal observations made twice a day, during daylight, one graduated staff.

These statements may be summarised as follows:—

Percentage of predictions within 15 minutes of the actuals.

	High water. Per cent.	Low water. Per cent.
Open Coast Stations	72	70
Riverain Stations	61	59

Percentage of predictions within 8 inches in height of actuals.

	High water. Per cent.	Low water. Per cent.
Open Coast Stations	98	96
Riverain Stations	70	62

The times and heights of high and low water at 15 Ports at which observations were taken and for which Tide Tables were published, were extracted in duplicate, tabulated and forwarded to Mr. Roberts, to enable him to eliminate, as far as possible, in future the larger differences between the actual and predicted values.

A table showing the average errors in the predicted times and heights of high and low water at 17 Ports for the year 1888 is also appended.

No. 1.

Statement showing the Percentage and the amount of the Errors in the Predicted Times of High Water at the various Tidal Stations for the year 1888.

Stations.	Number of comparisons between the actual and predicted values.	Errors of 5 minutes and under.	Errors over 5 minutes and under 15 minutes.	Errors over 15 minutes and under 20 minutes.	Errors over 20 minutes and under 30 minutes.	Errors over 30 minutes.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Aden	694	60	24	7	6	3
Kurrachee	693	32	42	13	10	3
Bhávnagar	704	18	34	15	20	13
Bombay	707	41	43	9	6	1
Mormugáo	696	37	41	8	11	3
Cochin	707	23	33	12	19	13
Colombo	697	31	34	9	13	13
Galle	702	38	36	8	9	9
Negapatam	229	21	42	13	17	7
Madras	694	30	30	8	7	25
Cocanada	707	34	46	10	8	2
Kidderpore	705	22	37	15	20	6
Chittagong	706	22	34	14	19	11
Elephant Point	319	17	42	20	16	5
Rangoon	696	29	45	13	8	5
Moulmein	365	28	37	13	15	7
Port Blair	702	39	40	7	6	8

No. 2.

Statement showing the Percentage and the amount of the Errors in the Predicted Times of Low Water at the various Tidal Stations for the year 1888.

Stations.	Number of comparisons between the actual and predicted values.	Errors of 5 minutes and under.	Errors over 5 minutes and under 15 minutes.	Errors over 15 minutes and under 20 minutes.	Errors over 20 minutes and under 30 minutes.	Errors over 30 minutes.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Aden	693	60	26	7	5	2
Kurrachee	690	34	41	11	11	3
Bhávnagar	693	19	28	14	22	17
Bombay	707	34	40	12	10	4
Mormugáo	699	38	40	9	10	3
Cochin	706	31	37	10	15	7
Colombo	690	30	37	9	10	14
Galle	690	40	34	7	10	9
Negapatam	225	14	27	10	25	24
Madras	699	31	29	9	6	25
Cocanada	705	35	38	11	9	7
Kidderpore	705	24	39	13	16	8
Chittagong	706	14	29	14	21	22
Elephant Point	317	29	36	10	19	6
Rangoon	694	27	39	12	14	8
Moulmein	366	29	38	12	13	8
Port Blair	703	39	38	7	7	9

No. 3.

Statement showing the Percentage and the amount of the Errors in the Predicted Heights of High Water at the various Tidal Stations for the year 1888.

Stations.	Number of comparisons between the actual and predicted values.	Errors of 4 inches and under.	Errors over 4 inches and under 8 inches.	Errors over 8 inches and under 12 inches.	Errors over 12 inches.
		Per cent.	Per cent.	Per cent.	Per cent.
Aden	694	93	7	...	...
Kurrachee	693	84	15	1	...
Bhávnagar	704	29	23	23	25
Bombay	707	71	27	2	...
Mormugáo	696	77	22	1	...
Cochin	707	91	9	...	...
Colombo	697	90	9	1	...
Galle	702	92	8	...	...
Negapatam	229	89	11	...	...
Madras	694	74	23	3	...
Cocanada	707	62	28	9	1
Kidderpore	705	38	27	15	20
Chittagong	706	23	24	24	29
Elephant Point	319	61	28	9	2
Rangoon	696	61	30	7	2
Moulmein	365	43	30	14	13
Port Blair	702	93	7	...	...

No. 4.

Statement showing the Percentage and the amount of the Errors in the Predicted Heights of Low Water at the various Tidal Stations for the year 1888.

Stations.	Number of comparisons between the actual and predicted values.	Errors of 4 inches and under.	Errors over 4 inches and under 8 inches.	Errors over 8 inches and under 12 inches.	Errors over 12 inches.
		Per cent.	Per cent.	Per cent.	Per cent.
Aden	693	93	7	...	...
Kurrachee	690	69	28	3	...
Bhávnagar	693	15	16	17	52
Bombay	707	70	25	5	...
Mormugáo	699	69	27	4	...
Cochin	706	83	17	...	...
Colombo	690	79	21	...	...
Galle	690	84	16	...	...
Negapatam	225	63	28	9	...
Madras	699	80	16	4	...
Cocanada	705	39	37	20	4
Kidderpore	705	42	26	13	19
Chittagong	706	35	27	21	17
Elephant Point	317	48	32	13	7
Rangoon	694	31	29	20	20
Moulmein	366	45	23	15	17
Port Blair	703	91	9	...	...

No. 5.

Table of Average Errors in the Predicted Times and Heights of High and Low Water at the several Tidal Stations for the year 1888.

Stations.	Mean Range at Springs in feet.	Average Errors.					
		Of Time, in minutes.		Of Height, in terms of the Range.		Of Height, in inches.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
Aden	6·7	8	8	·025	·025	2	2
Kurrachee	9·7	11	11	·017	·026	2	3
Bhávnagar	31·8	18	18	·024	·037	9	14
Bombay	14·5	9	11	·017	·017	3	3
Mormugáo	7·1	10	10	·036	·048	3	4
Cochin	3·2	17	13	·052	·052	2	2
Colombo	2·4	17	16	·069	·104	2	3
Galle	2·2	12	13	·076	·114	2	3
Negapatam	2·6	14	21	·064	·128	2	4
Madras	3·5	28	28	·071	·071	3	3
Cocanada	5·2	10	12	·064	·096	4	6
Kidderpore	11·7	14	14	·057	·057	8	2
Chittagong	13·5	15	20	·062	·042	10	8
Elephant Point	19·2	15	12	·017	·022	4	5
Rangoon	16·4	12	13	·020	·040	4	8
Moulmein	12·7	12	14	·046	·046	7	7
Port Blair	6·6	11	11	·025	·025	2	2

Bench-Marks.

In carrying out the inspection of the tidal observatories during the year under report, the several bench-marks of reference at each station were connected by levelling with the bed-plate of the tide gauge and were found generally in a satisfactory condition; the only exceptions were as follows:—

At Aden, B. M. A.' situated on the pier was found to have settled 0·054 foot.

At Akyab, B. M. A. on an iron pillar was found to have settled 0·062 foot.

At Rangoon, the bench-mark which was originally intended as the standard bench-mark for Rangoon, and referred to on pages xxxviii and xxxix of the Annual Report for 1886-87, was found to be gradually settling, and as it was reported by the Vice-Chairman of the Port Commissioners as being considerably in the way of the traffic on the wharf, it was considered unnecessary to retain it as a bench-mark and permission was given for its removal.

During the year, the following new bench-marks were laid down:—

At Elephant Point.—A bench-mark was embedded in a block of masonry 3 × 3 × 2½ feet near the Government Telegraph office and was connected with the bench-marks at the observatory site.

At Mergui.—Two bench-marks of reference were embedded in blocks of masonry 3 × 3 × 2½ feet near the Post Office and were connected by levelling with the bed-plate of the tide gauge.

Levelling Operations.

The operations of the last season comprised the following lines of double levelling:—

Section I.—From the Bangalore Base to Mangalore.

Section II.—From Bidar to Hyderabad (Deccan).

The sanctioned programme for the season was to carry a line of double levelling from Bangalore to Mangalore, connecting *en route* any stations of the survey that may be practicable; and on the completion of this line to move the party to the Bidar Base and carry a line of levels thence *vid* Hyderabad to Bezvada near the mouth of the Kistna, to close on the line of levels carried on during the previous season. Thus it will be seen from the work actually completed that the programme was not carried in its entirety; this was due to the exceptionally hilly nature of the country levelled over on the Bangalore-Mangalore section, which occupied the levelling detachment from the 3rd November 1888 to the 10th April 1889, or a little over 5 months; whereas it was estimated, on the supposition that the country would offer no very great difficulties for levelling, to take only 3 months. Colonel Rogers, in paragraph 5 of his letter No. 357, dated Poona, 24th April 1889, proposed the curtailment of the season's work; and a modification of the second portion of the programme, by which the line Bidar to Hyderabad was to be completed before closing work for the season, was ultimately decided on; the intention being to complete the line thence to Bezvada in season 1889-90, and subsequently to take up the line Nowanar to Tatta *vid* Lakhpat. The out-turn of work consisted of 307 miles of levelling along the main lines, and 16 miles of branch lines to connect Trigonometrical stations, making a total of 323 miles and involving a rise and fall of 30,782 feet. The instruments were set up at 5,640 stations and in the course of the work 33 embedded and 278 ordinary bench-marks were connected; besides these, 9 Great Trigonometrical Survey Stations, 1 Railway and 3 Public Works Department bench-marks were connected.

By comparing the figures in the abstract given below, it will be seen that though the distance levelled this year was less, yet the labour expended in accomplishing it was considerably greater than in the 3 preceding years.

Abstract.

Season.	Number of miles.	Number of stations at which instrument was set up.	Total rises and falls.
			Feet.
Season 1885-86	526	3,709	7,276
Do. 1886-87	450	4,041	14,017
Do. 1887-88	545	3,796	12,423
Do. 1888-89	323	5,640	30,782

The following extracts are taken from the report submitted by Mr. Bond on the work performed by him:—

* * * * * * * * * * * * * *

"Owing to incessant rain no observing could be done until the 3rd November; during the interval, however, the camp equipment underwent all needful repairs, the instruments were examined, cleaned and adjusted, and the levelling staves compared with the 10-foot portable Standard Bar."

* * * * * * * * * * * * * *

"*Section Bangalore-Mangalore.*—One of the principal objects of the levelling operations being the connection of stations of the Great Trigonometrical Survey, in order to secure independent checks for the values of Geodetic heights, I was particularly instructed to select the most advantageous route from Bangalore to Mangalore so as to carry out the desired object.

"I was enabled to decide from local information that the route *viâ* Mágadi, Kunigal, Hassan and the Mánjarabad Ghát would be the best; and as it passed through the Great Arc, the Madras Longitudinal and Mangalore Meridional Series, I determined to follow it and selected the following conveniently situated stations for connection:—

"Rangaswámibetta H. S.
"Hálibetta H. S.
"Chanráypatna fr. s.
"Hassan S.
"Mánjarabad fr. s.
"Kittávar H. S.
"Ballamale H. S.
"Mangalore. S.

Of these, all with the exception of two, *viz.*, Hassan S and Kittávar H. S., were connected. The bastion on which Hassan S. stood had been completely destroyed to make room for the extension of the town; and the temple on the roof of which Kittávar H. S. was built was found to have collapsed.

"I started work from the south-west end of the Bangalore Base Line, connecting bench-marks Nos. 79, 78, 77 and 76 of the section of levels from Jalárpet to Bangalore, *vide* page 163 of Spirit-Levelled Heights, No. 1, Madras Presidency, Seasons 1869-85; and continuing along the Railway line to a distance of half a mile south of the City Railway Station, joined the road to Mágadi, after which the line of levels was carried along the route above mentioned closing the section on a newly-embedded bench-mark at the Custom House, Mangalore, on the 10th April 1889.

"The length of this section with branch lines amounted to 235 miles of very heavy work over the undulating plateau of Mysore and thence down the Ghâts to Mangalore; the total rises and falls in this comparatively short distance, amounting to 26,060 feet, entailed the setting up of the instrument at 4,598 stations, giving an average of 20 stations per mile and 38 stations per working day.

"Twelve (12) check points previously determined by spirit-levelling were connected, *viz.*, 1 embedded and 3 inscribed bench-marks at Bangalore, and 1 embedded, 4 inscribed (two formerly and two now) and 3 other bench-marks at Mangalore: besides which 25 newly embedded bench-marks, 1 Irrigation, 1 Railway, 203 inscribed on rocks *in situ*, bridges and other prominent land marks, and 6 Great Trigonometrical Survey Stations were also connected, making a total of 248 points in all."

* * * * * * * * * * * * *

"On the completion of the work at Mangalore, the party was delayed a few days awaiting the arrival of the British India Steam Navigation Company's Steamer to take them on to Mormugáo, where they landed on the 14th April, and proceeded by rail to Gulbarga, arriving on the 19th. Arrangements had to be made for the journey by road to Bidar, and when the camp was ready to start, an incessant downpour of rain for three days kept it weather-bound, and we did not reach Bidar until the 3rd May 1889."

"*Section Bidar to Hyderabad (Deccan).*—I was instructed to begin this section from the embedded bench-mark at Bidar No. $\frac{46}{211}$ of section II of Spirit-Levelled Heights Nos. 2 & 3, Bombay Presidency, 1877-80, and to verify its stability by connecting it with the west end of the Bidar-Base Line and bench-marks Nos. $\frac{47}{211}$ and $\frac{48}{211}$.

"On reaching the west end of the Base, which was four miles from the camp, the station was found completely destroyed, and I was informed by the Tahsildar of Bidar that the pillar was removed about six years ago by thieves in search of treasure supposed to be embedded under the circular pillar.

"Bench-mark No. $\frac{48}{211}$, which is described in the pamphlet as being cut on a rock *in situ* a mile north of Bidar Fort, could not be found.

"The embedded bench-mark No. $\frac{46}{211}$ was therefore verified by a connection with bench-marks Nos. $\frac{48}{211}$ and $\frac{47}{211}$ before beginning this section.

"The line of levels was carried along the cart track *viâ* Sangam to Chalmeda, thence across country *viâ* Goraigat H. S to Goblavaram and thence along the high road from Sholápur *viâ* Sadashipet, Pattancheru, Lingampalli and Secunderabad to the Chaddarghát Residency, Hyderabad, closing work on a small rocky eminence in the Residency compound, where the usual $\frac{G.\ T.\ S.}{B.\ M.}$ was engraved.

"Work was commenced on this section on the 6th May and closed on the 17th June 1889. The length including branch lines amounted to 88 miles of double levelling, the total rises and falls to 4,722 feet, and the instrument was set up at 1,042 stations, which gives an average of 12 stations per mile and 31 stations per working day.

"Eight (8) embedded, 63 inscribed and 2 Public Works Department bench-marks were connected; besides the following Great Trigonometrical Survey Stations:—

"Shilápalle H. S.
"Goraigat H. S.
"Naubatpahár h. s."

* * * * * * * * * * * * *

"The health of the establishment was very good until the party got into the Malnad, when frequent attacks of fever disabled four or five men daily; the short stay, however, at Mangalore, pending the arrival of the steamer enabled all but three to recover, two of these men were invalided from Gulbarga and the third was never fit for field work during the remainder of the season, and I hear has not yet recovered.

"I am considerably indebted to Major H. C. Fox, R.E., Executive Engineer, Secunderabad, for the courteous and ready help he invariably gave me, without which I should have been put to much inconvenience and trouble when working at Hyderabad."

UPPER BURMA.

NORTHERN SHAN STATES AND BHAMO DISTRICT.

Extract from the Narrative Report of MAJOR J. R. HOBDAY, S.C., *in charge No. 21 Party—season 1888-89.*

At the beginning of the season hearing that Lieutenant Daly contemplated an expedition from the Ruby Mines to Taungbaing and back to Thibaw, I thought it would be a good opportunity for instructing Lieutenant Renny-Tailyour in his work. We arrived at Mogok, the centre of the Ruby Mines, on 1st December, but on Lieutenant Daly's receiving news of a disturbance in the remote State of South Theinni, our plans were suddenly changed, and it was decided to march straight to the scene of the revolt at Maingyè, the

capital of South Theinni. We left Mogok on 7th December, reached Thibaw on 17th and Maingyè on 25th December; this included three days' halt at Thibaw. The road between Mogok and Thibaw is a very rough one, little used of late, across a rugged mass of hills, which taxed our transport animals considerably. On the other hand the road from Thibaw to Maingyè lies across a fine open country. On our approach to Maingyè, the Sawbwa, who had hidden himself on the slopes of Loilin hill, came down from his retreat to meet us. We found the town and the Sawbwa's palace sacked and burnt by the insurgents, who were said to be in force within a short distance in the Meungha district; so we determined to march straight for the scene of action, the road taking us over a range of hills, before descending into the valley of the Namha river, which we reached unobserved by the insurgents.

In the evening we visited the breastworks of our allies, built on small hillocks on the west bank of the Namha from whence we could plainly discern the enemy's works similarly built on the opposite bank. We then got an insight into Shan warfare. Now a man emerges from his entrenchment, and creeps down towards the river and under cover of a hayrick discharges his musket at an impossible range; then numbers of them appear outside their positions and indulge in shouting and jeering at each other, in language of the choicest. This sort of warfare, we were told, had been going on at this spot for the past fortnight, the mornings and evenings being the busy time whilst during the heat of the day they lie snug within their entrenchments. The following morning we made an attack on the centre of the insurgents' position, which was reached at daybreak, by a circuitous route. The insurgents offered small resistance, and fled in disorder up the slopes of the adjacent hills; some half a dozen of them were killed, and one military policeman was wounded. Having dispersed these bands we retired to Maingyè, where we were compelled to halt some days for the arrival of rations from the rear.

During this delay an attempt was made to ascend Loilin, elevation 8,842 feet situated north, and about 15 miles distant from Maingyè. We arrived with a small escort as far as the Palaung village of Hokyem, situated on one of the spurs of Loilin, but on looking into the valley below, the town of Maingpat was observed to be in flames, and the inhabitants seen bolting up the slopes of the hills with their goods and cattle. As the villagers at Hokyem were in terror of being attacked by the insurgents, and were unwilling to show us the road to the summit of Loilin, and as under any circumstances we should have had to leave our escort and camp at Hokyem, we reluctantly gave up the project and returned to Maingyè. By this time the much needed rations had arrived, and a fresh start was made. We now visited Hoya, Maingpat, Tangyan and Maingma, through a fine country denuded of inhabitants by the insurrection. Although we made a large sweep across this land of desolation, we failed to come across the insurgent bands, who were probably well on their way back to Mothai and Mangleun, across the Salween. From Mankat, we again ascended the spurs of Loilin from the east by a fair hill track, and reached a point within three miles of the summit, where we bivouacked for the night; the following day at daylight we started afresh. Our track soon ceased, and for the last three miles we had steadily to cut our way up to the summit, which we did not reach till 2 P.M. What appeared to us from the valley below to be grass, growing on the summit of the hill, turned out to be a slender feathery bamboo, about 12 feet high, and growing as close and thick as rice. From the crest of Loilin, a good view is obtained all round, except to the north where a long ridge, covered with rhododendron trees, obstructs it. The air was not very clear unfortunately, but two hours enabled us to get some useful observations, after which we had to hurry down the western slopes to find a spot to encamp for the night.

The descent at the commencement is steep, after which we picked up a small track, which we followed, but night overtook us before we found water, and we had to turn in without that desirable commodity. We started at daybreak the following morning, and at length, about 8 or 9 A.M., we arrived at a stream, where a wash and feed were generally appreciated. We then made for the village of Hoya, situated in the plain to the west of Loilin, where we had arranged to rejoin Lieutenant Daly and the main party. We only just managed to do it after two long ascents and three descents, walking our best the whole day. From Hoya, we sent the infantry to Maingyè, and returned with Lieutenant Daly and the mounted infantry to Thibaw. After a halt of a day or so, Lieutenants Donne and Renny-Tailyour returned with me to Mandalay, where we arrived on the 2nd February.

Between Mogok and Thibaw, much new ground was traversed, and again beyond Loilin towards Tangyan, which is within a march of the Salween. The triangulation was much strengthened, and connected in the vicinity of Maingyè, with that which Captain Jackson brought round the previous year from Mandalay, *viâ* Meiktila, Fort Stedman, Mone and Legya to Maingyè, the discrepancy in the common point of junction being 5 seconds of latitude and 10 seconds of longitude.

* * * * * *

In April, I accompanied a column of troops under Brigadier-General Wolseley, C.B., against the tribe of Ponkan Kachins who live in the hills south-east of Bhamo, and who had been committing raids within British territory. Two attempts were made in April and May 1886, to coerce this refractory Kachin Sawbwa to submission, but the columns engaged failed on both occasions to reach the objective: firstly, owing to a deficiency of hospital ambulance to carry the sick and wounded; and secondly, on account of representations made by the Political Officer accompanying the expedition. I had the misfortune to accompany the troops on the second occasion. However, this time, instead of marching

by the direct road to their stronghold, we advanced in two columns along ridges on both flanks mostly through country peopled by friendly Kachin tribes. Our foes not being prepared for these manœuvres were entirely taken by surprise, and we were in possession of Karwan, the Sawbwa's capital, with comparatively slight opposition. The villages of Karwan, Pantat and Ka-Oo are built within a few hundred yards of each other, on the summit of a long ridge about 4,000 feet elevation, somewhat isolated from the confused mass of surrounding hills. The houses are from 50 feet to 80 feet in length, and contain three or four families, together with their live stock of cattle, pigs, &c. In the three villages above named there must have been from 300 to 400 of these houses, strong substantial dwellings, rather dark inside, and full of fleas. Most of these houses were committed to the flames, those in Ka-Oo being spared, on the villagers coming in to sue for terms.

The Kachins are uncommonly clever at choosing defensive positions, and in blocking up the roads that lead to their villages in the hills by felling large trees, bamboos, &c., across them. As regards defending their stockades, they do not remain long after discharging their guns, but seem to glide off into the forest in a most mysterious way, so that even to see a Kachin on these occasions is of rare occurrence. The day after the capture of Karwan, whilst I was out surveying, a *khalási* whom I had left behind in camp, wandered too far down the slope of the hill in search for water and was unfortunately killed. There was a good deal of desultory shooting all around on that day, but after this, all opposition ceased and not a shot was fired. A small portion of the force then marched across the hills to Namkham in the valley of the Shweli (*Shan*, Nammow) river where we met Lieutenant Daly, the Superintendent of the Northern Shan States, who had lately arrived from Lashio. This enabled me to form a junction with Lieutenant Renny-Tailyour (who had accompanied Lieutenant Daly) and complete the circuit of our triangulation, brought from Mândalay, across the Shan States to the Salween river, round to Bhamo and thence down the valley of the Irrawaddy, the discrepancy in the common point of junction near Bhamo being 2 seconds of latitude and 16 seconds of longitude; a very fair result considering the great distance traversed, and the difficulty, only known to those who have ever attempted it, of carrying on a triangulation whilst marching rapidly with troops.

At Namkham we found ourselves on the borders of the Chinese Shan State of Meungmow, a fine alluvial plain of about 4 miles in width, stretching for some 20 miles as far as the town of Meungmow where the Shweli river bifurcates into two channels which eventually meet again near Namkham. The valley is studded with numerous large villages, and the inhabitants all appear contented and prosperous and their rice-fields are well irrigated by streams which flow down from the hills on either side, rising to an elevation of nearly 8,000 feet east of Namkham. After two days' halt at Namkham, I returned with our little force to rejoin the main column at Karwan. During our absence the indemnity had been paid by the Kachins, and most of the captives released; so we started on our return journey to Bhamo where we arrived on 14th May a month after we left it.

Owing to the unhealthy climate of Bhamo during the rains, a sanatarium is much needed for the garrison. There are some fine hills rising from 6,000 to 8,000 feet due east and within three marches of Bhamo, where a site could undoubtedly be found. We were to have reconnoitred this locality, but our expedition to Namkham took up time; the season was far advanced and our Goorkhas were under orders to return to their regiment, and as the General would not allow me to go without them the project had to be abandoned.

KARENNI AND SOUTHERN SHAN STATES.

Report on the Survey Operations with the KAREN FIELD FORCE *and in the* SOUTHERN SHAN STATES, *by* CAPTAIN H. M. JACKSON, R.E.,—*season 1888-89.*

Having been appointed for Survey work to the column destined to bring to his senses the ill-advised chief of the "Red Karens," I started from Rangoon on the 12th of November 1888 and, thanks to the new Mandalay Railway, arrived at the station nearest to Meiktila on the 16th. From Meiktila, I obtained my transport animals, and going up by the old road, arrived at Pwehla on the plateau on the 22nd. From Pwehla I went straight south to our attempted sanitarium at Konni, from which place I completed and continued the triangulation, which had previously only just reached thus far. Then leaving my sub-surveyor Mahomed Hosein to fill in the detail of this portion of the Myèlat, which he did very thoroughly, I crossed the Enlé lake to Fort Stedman. Here I found that the Karen column was not to start until the 22nd of December; but that Mr. Hildebrand, the Superintendent of the Shan States, was just starting down to Mobye on a diplomatic mission, so, at his invitation, and thinking it would be a good opportunity of getting some triangulation done in advance, I decided to accompany him. In light boats, impelled by as many rowers as could find standing room, we reached Pèkon, some 60 miles' run, in one day; there we stayed three days; so I was enabled to measure a check base, observe an azimuth and complete the triangulation, which I had been prevented by illness from doing on the former occasion of our visit to this place.

From Pèkon we went on by the river to Mobye, the southernmost of the Shan States —Shan as to its ruler and traditions but half Karen in blood. Here we stayed three days, and so I was able to fix some points ahead in Karenni, which proved subsequently very useful. From Mobye the hills open out east and west from the valley of the Belu-Chaung, enclosing the great alluvial plain, which, under the careful cultivation of the Karen, has become one immense rice-field dotted with many large villages. Through it the Belu-Chaung winds its devious course until it reaches the lower hills on the east; to this point the river is navigable; thence, narrowed into a rocky channel, it falls rapidly until it finally sinks into the ground within sight of the valley of the Pôn. From Mobye we went back by road to Pèkon; here Mr. Hildebrand left me to make my own way back, as I wanted to carry the triangulation properly up the valley. This I managed to do, and got back to Fort Stedman in time to work out my observations, make my commissariat and transport arrangements and get in my sub-surveyor from the Myèlat.

The column began to start on the 22nd December; I left on the 24th. We went along the route, on the east bank of the Belu-Chaung, traversed by the "South Shan Column" of last year, as far as Nammaw Kala, five marches. From this onwards it was new country, and by the next march we were in the land of our red-breeched foes. On 1st of January 1889, having avoided the road on which the enemy had made arrangements for giving us a warm reception, we came upon them in a manner mutually unexpected; and after a short resistance on their part, the Biluch Mounted Infantry got them well away in the open and made a somewhat sanguinary example of them. The column made at once to Loikaw, where it was expected the chief stand would be made, but the enemy had left previously. At Loikaw we crossed the river. Between this place and Sawlon, as I was not allowed to leave the column, I could only assist the sub-surveyor in carrying on his plane-table traverse by getting bearings from such points as I could slip up to *en route*. This work the sub-surveyor did fairly well, though occasionally the rattle of musketry may possibly have interfered with the accuracy of his measurements. On one occasion I observed his plane-table put to a novel use by the ingenious *khalási* carrying it; he propped it up in the direction of the enemy's fire and sat small behind it.

From Loikaw we descended to the valley of the Pôn river, about 2,000 feet below, and crossing after some little difficulty, marched with occasional skirmishes along the left bank of that river, which is here closely shut in by the hills on both sides, until we reached the capital of the country, Sawlon. Here we found that the pigs and fowls were the only inhabitants left; and these were not left long. Sawlon is a large village loosely stockaded, well built on a low spur running out into a widening of the valley of the Pôn. A stream falls almost perpendicularly from about 300 feet above the village, and the water is led through it and along each side of the main street in wood-cased drains. This street is also lighted by means of the familiar lamp post. These evidences of civilisation, borne out further by the articles of furniture, etc., left in the palace, would point to a ruler of advanced ideas in the ex-monarch, were it not too well known that he was far from living up to his "blue china." The hills above Sawlon to the east, *i.e.*, between the valleys of the Pôn and Salween, rise to 5,300 feet. Having climbed one of the highest peaks of these, I obtained a very fine view of the country round, with the blue-green Salween winding its way through the hills to the east.

From Sawlon, expeditions were made to the large and rich Shan villages of Yuathit and Sadaw, the former four miles, the latter about twelve miles from the Salween. These I accompanied; and with another expedition to Bawlakhe, capital of a neighbouring petty state of that name, I sent the sub-surveyor. From Yuathit we reached the Salween, here about quarter mile wide, and running smoothly over a sandy bed. There is no cultivation along the banks however, nor from the formation and nature of them is there any apparent possibility of it. Yuathit and Sadaw had both furnished and lost many of the chief men who had fought against us. The villages received our detachments, however, with perfect amiability. On the banks of the Salween, near Yuathit, we met some Siamese officers. The Siamese are not sorry for the Red Karen. I regret that I had not time to reach the Salween from Sadaw; but I was able, I think, to fix fairly accurately its course east of this place.

The altitude of the Pôn valley at Sawlon is about 150 feet, and of the Salween east of Yuathit 140 feet. The temperature even in January in the confined valley of the Pôn is very high. The hills between the Pôn and Salween seem to catch and hold a good deal of water. The ground to the west of the Pôn, however, the decline of the Karenni plateau to the south, is singularly waterless. The cultivators of the *taung-yas* on these slopes fetch their water from great distances and store it in large bamboos; perhaps it is needless to remark that they only use it for drinking and cooking. The Shan fugitives from Sawlon had soon plucked up courage to return; and long before we left on the 23rd of January (the ex-king still unfound, but a since well proved efficient substitute reigning in his stead), the village was fairly full and going about its daily work as if nothing had happened. I should mention that while our column approached Sawlon from the north, another made for it from the south up the valley of the Salween. I had a sub-surveyor with this, who succeeded in plane-tabling from the Great Trigonometrical points near Papun to as far as the force went, and fortunately sufficiently far for a plane-table junction to be made with my work, as we had no opportunity of meeting, though I was able to instruct him by letter.

On our way back from Sawlon I obtained ocular evidence of the sinking of the Belu-Chaung. The river continues nearly its normal width up to the first spot where its waters are carried into a fissure or cavern in the limestone; from this place it becomes an intermittent river of roundish pools, the number of its channels varying with the water-supply, until its apparently last stream drops into a conical basin lined thickly with mud, and then, whirled round and round, disappears through a hole at the bottom, as through an immense sink. Where this water joins the Pôn river 2,000 feet below, as evidently it must somewhere, I was unable to discover.

Two marches from the Pôn we turned westwards into the "West-Karen" state of Ngwèdaung, the capital of which is by far the largest village of the Karens. It is famous for its silver work, the metal being found in the hills near to the south. From Ngwèdaung we turned northwards into the important and loyal state of Pobya. The large villages in these Karen states show great general prosperity, though the paucity of their inhabitants at present tells of the disturbed state of the times. The chief characteristic of a Karen village is its extreme dirtiness; it is impossible to imagine anything dirtier. Even the many pigs are not equal to their task of scavengers: they even seem to have given it up as a bad job.

From Pobya we reached Mobye, and hence the main column continued its way home, leaving a detachment as the superintendent's escort during the settlement of the long disputed boundary between Mobye and Pobya. In this I was asked to help; and this work took up a good deal of my time here, though, whilst preliminaries were being settled, I completed as much triangulation as was possible in the then thickening atmosphere, and started the sub-surveyor on detail work which he kept up until we left northwards on the 19th of February. The usual smoke haze had now set in.

From Pèkon, in the company of the Assistant Superintendent of the Shan States, I struck up west on to the end of the Myèlat plateau, sending the sub-surveyor by another route. I had intended to accompany the first mentioned officer in an expedition westwards; but finding it doubtful where this would land me, I decided to cut myself adrift, and accordingly proceeded alone northwards up the Myèlat, triangulating and plane-tabling *en route*. We managed, I think, to get in most of the detail of this well cultivated and comparatively thickly populated part of the states. I found the people without exception friendly and obliging; especially when well paid. Supplies, however, other than rice and tomatoes, were not to be had. We arrived back at Konni on the 5th of March.

From Konni I made a short trip to the south-east to complete a bit of country lying rather too far off our previous route, returning in time to start with the Assistant Superintendent in charge of the Myèlat on an expedition northwards. Having made Pwehla in one march, we passed through the sub-states of Kyaukkuléyua and Myaing to Ywangan lying at the top of the Natteik Pass, through which the Mandalay road goes. After leaving Pwehla in this direction, cultivation becomes less frequent as one gets northwards. This is probably less the fault of the people themselves than the result of disturbances caused by gangs of banditti driven up from below. Ywangan is a fairly large and apparently prosperous village.

Here the Assistant Commissioner left me to return south; and I went on north into the northernmost of the states of the Myèlat, Bawlèzèleywa, now under the jurisdiction of the Kyauksé district below. Here I was particularly well received and treated by all. From Baw I crossed the Mènètaung, the main ridge of the plateau, at an altitude of 6,600 feet, through pine forest and white rhododendron in full blossom. On these hills I obtained a specimen of a pheasant very similar to one of the Himalayan species; and I may mention that in Kyaukkuléyua above referred to, on the rocky hills of the western edge of the plateau, the *serow* seems from the tracks, etc., fairly plentiful. One was shot by a Burman whilst I was there.

Descending the eastern slope of the Mènètaung, we reached Yatsauk, capital of the state of that name, on the 9th of April. This, one of the largest of the Shan states, is now slowly recovering from the effects of the troubled times of two years ago; but still much of its land that should be cultivated lies barren. Working north from Yatsauk we descended the Zawgyi valley by the main "Thibaw road," on which the villages lie far apart, divided by stretches of thick jungle, and proceeded as far as Indaw, a large and prosperous village, still in Yatsauk territory. From this I reached the point at the Tadagyi or big bridge, at which the Zawgyi turns west towards Burma. We returned from Indaw to Yatsauk by the same road, there being no time to do anything else.

From Yatsauk we marched back into the Nyaungywé valley by the "eastern" road through the waste land and deserted villages lying between these two states. After a short *détour* into the Tabet valley to improve some triangulation, I returned by a very easy and gradual descent from the high ground at the head of this valley, about one march to the north of the usual trade route, which ascends by a zig-zag path always very bad in wet weather.

I now went up north-west into the petty states of Kyauktat and Bawzain, hitherto unsurveyed. In Bawzain a considerable amount of silver and lead is worked in a primitive kind of way. The mines are in no places deep, but they make up for that by their frequency, so much so, that parts of the country would seem to have been the dwelling places of some monstrous kind of rabbit. The forge bellows used in smelting consist of two large hollow bamboos with vertical pistons. These, as far as I could see, are generally worked by women; the fair sex indeed takes a very fair share in the labour in the Shan states.

Having completed Bawzain up to the borders of Yatsauk, I marched west to Pindeya, where, leaving the sub-surveyor to complete the detail of this most populous little province, I climbed to the highest point of the Mènètaung, and from this satisfactorily joined together my triangulation on either side. This range is the highest after the Loi-saing of any on this side of the Salween. Its ridge is like that of many in Southern India, grass-covered, with "sholas" of evergreen forest. Water seems scarce on it. I should imagine from the set of the vegetation on this and other high levels in these parts that there is a high wind from the west always blowing over them. I have never known it drop whenever I have been up above 5,000 feet in these parts, and it is always a cold wind. On this occasion, on the top of the Mènètaung (at a height of 7,768 feet), we were shivering in a bright May sun. The Zawgyi river rises a short way to the north of Pindeya, from under the eastern slope of the Mènètaung, in a way peculiar to rivers in these parts. It emerges from two apertures in the base of a steep slope as a full-grown river. The twin streams unite after a few yards.

From Pindeya we crossed the Mènètaung at its southern end, and arrived again at Minchadu below its western slopes. During our previous visit here it had been so hazy that I found my triangulation was insufficient; hence I decided to make this round on our return. This time I was more fortunate, some rain having fallen, and I completed everything satisfactorily. From Minchadu I took my party back south to Konni in order to return to Burma by a new route. After some delay in getting bullocks, we turned our faces west, and going through the petty states of Myinmati and Taungla, pitched our fourth camp on the head-waters of the Panlang, which flows south through narrow gorges into the Sittang river. From the other side of this water-shed the streams of the Myetha and Matha flow north into the Zawgyi and so into the Irrawaddy. From this point an extremely good track leads right along the ridge of a narrow spur to the edge of the hills overlooking Yamethin. Our descent was a little delayed by rain and because I had to complete the triangulation before leaving this vantage ground, and one injudiciously chosen camp was nearly washed away by the unexpected rising of a mountain stream; but, eventually, everything that could be was done; and we reached the shelter of Yamethin over miles of flooded road on the 12th of June 1889. Thence the railway took us back to Rangoon.

Northern Shan States.

Extract from the Narrative Report of Lieutenant T. F. B. Renny-Tailyour, R.E.—*attached to No. 21 Party,—season 1888-89.*

I left Mandalay on the 8th February 1889, arriving at Maymyo on the 11th, where I halted until the 17th waiting for Mr. Sherriff, who came up as the representative of the Rangoon Chamber of Commerce, and Lieutenant Willcock who was attached to the Intelligence Department. During this halt I went up to Chinitaung station, made a new station called Nongkang, and took observations for azimuth, etc.

On the 17th we left Maymyo. I revisited some of the old stations near the road, and obtained some angles that were required. The weather was getting very hazy, and a few days after leaving Maymyo it was impossible to see distinctly beyond two or three miles.

We halted on the 27th February at Thibaw, where we had to cross the Myit-ngé river by a ferry. At Sé-eng we crossed the boundary river between the Thibaw and the Northern Theinni States; this river was only just fordable. The country between Thibaw and Lashio was jungly and very thinly populated. Lashio (about 2,600 feet elevation) we reached on the 4th March and found Lieutenant H. Daly, the Superintendent of the Northern Shan States, encamped near the site chosen for the police post. Sub-Surveyor Faida Ali was also at Lashio. Here we were obliged to wait until the Shan levy of Military Police arrived, as some of them were to form part of the escort on our tour. The levy did not arrive until the 7th April.

During our halt at Lashio, I measured a base, formed several stations and took observations for azimuth, etc. I also went out on several short trips with Faida Ali, who worked with the plane table; but the haze was too dense for me to do any satisfactory triangulation. During our halt at Lashio, the Sawbwa of Northern Theinni, Kon San Ton Hon paid us a visit; he is a quiet man with nice manners and appears to be popular. He was accompanied by a dirty rabble of two or three hundred Shans armed with a peculiar assortment of old guns.

We at last left Lashio for our tour on the 13th April. The road lay over fairly level country for the first few marches as far as Pangtong, a small village on the right bank of the Myit-ngé river. The river here runs through a kind of gorge and is very rapid and rocky in places: we crossed by means of two small boats. After leaving Pangtong the country was very hilly, but is fairly well populated by Palaungs, a hill race, dirtier, shorter and uglier than the Shans. Their villages are generally on ridges of the hills and the houses are fairly large, the ends being rounded off and the roofs coming very low down, making the interiors very dark. The Palaungs work hard at their hill cultivation, but are no good in the plains and invariably suffer from fever and home sickness. The hills here are covered with tea shrubs which is the great cultivation of the Taungbaing State. Namsan the capital we reached on the 20th April; it is situated on a ridge at an elevation of about 5,000 feet. The Sawbwa's palace (a large building, but very dark and dirty

inside) and a large *kyaung* are built on two knobs of this ridge and stand well above the village. Namsan is a great centre for bullock and mule caravans which take down enormous quantities of tea to Mandalay, and return with rice, salt, cloths, etc.

The Taungbaing Sawbwa is a big, heavy-looking man and always carries a dirty towel in his hand. This seems to be the fashionable custom, as most of the officials we met also carried one. The Sawbwa had several wives, two of them being especially good looking, and lots of children. We halted at Namsan for a couple of days and the haze which had been very dense since leaving Lashio now cleared slightly. I visited and observed from three hills and also took some observations for azimuth, etc. It was impossible to measure a base here.

On the 23rd April, we left Namsan for Namkham, which place we reached on the 5th May after 13 days' marching without a halt The country passed over was hilly and fairly well populated with Shans, Palaungs and Kachins.

The Kachins are a race of people very like the Palaungs in habits and appearance, but, if possible, dirtier; they are very fond of money and are always on the look out for a deal, such as selling fowls, eggs, etc. They are supposed to be good fighting men and as such are much feared by other races. Their villages are built in the same style as those of the Palaungs, but the houses are much larger and generally hold 30 or 40 people in each as well as any amount of cattle, pigs, fowls, etc., underneath.

Between Namsan and Namkham we had several heavy thunderstorms which cleared the atmosphere for short intervals. I attempted to keep up a triangulation, but was only partially successful, owing to the jungly nature of the hills, the thickness of the atmosphere and the rate we were marching. Namkham, about 2,600 feet elevation, is situated near the lower end of a very rich rice-growing valley and near the left bank of the Shweli river, which is here too large to be ever fordable and which runs down the valley. This valley is about 15 miles in length and from 2 to 4 miles in breadth. The Shweli river is here the boundary between our Shan States and the Chinese Shan States, into which country we were not allowed to go. This valley is by far the richest piece of country I have seen in the Shan States, and it appears to have been undisturbed while nearly all the rest of the Shan States, were in more or less an unsettled condition. A great proportion of the people are Chinese Shans. The *kyaungs* about Namkham are all built after the Chinese type.

On the 5th May, the Northern Theinni Sawbwa arrived on a tour of inspection through this part of the country: he had a following of nearly 1,400 men. All his followers I believe got rice, etc., free from the villages passed through, and it appears that all the young men near his line of march who feel inclined for change of air simply join on and get their change with free rations into the bargain. This probably accounts for their large numbers.

On the 6th, General Wolseley, with Major Hobday and six other officers, arrived from Bhamo and stayed a couple of days; on leaving they took Mr. Sherriff away with them.

While halting at Namkham, I measured a base, took some observations for azimuth, etc., and visited and observed from two small hills near. Faida Ali put in a good deal of country round about with his plane table. From here I sent my interpreter Maung San by the straight road to Theinni, this being the only chance of getting this road sketched.

On the 15th May, we left Namkham and marched up the valley to a village called Seram situated on slightly rising ground and fortified with a very strong bank and ditch all round. During our march we got wet through with a thunderstorm and this seemed to be the commencement of the rains, as it rained daily afterwards as long as I was in the Shan States. We halted at Seram until the 19th waiting for certain Kachin Chiefs to come in to see Daly and the Sawbwa who was now marching with us. The Chiefs all came in satisfactorily. It is generally found very difficult to get the proper revenue out of the Kachins as they hate parting with any money, and they generally have to be threatened before they pay up.

I observed from three stations near Seram and Faida Ali completed his map of the valley. The weather now cleared up considerably and gave me a chance of keeping up a triangulation.

From Seram we marched over hilly country without a halt until the 24th May when we reached Meungsi. I managed to keep up the triangulation; amongst several hills I went up was a conical one called Ayhpong which made a capital station, being almost bare and over 7,000 feet in height. The name is I believe Chinese and near the top there were several Chinese villages: opium and potatoes were growing all round the hill. Meungsi, about 3,500 feet in elevation, is situated in a small rice-growing valley. We halted here until the 30th, and I observed for azimuth at our camp and visited and observed from a hill, Loi Panglom, some six or seven miles off. At Meungsi we had a good deal of rain and the hill tops were almost continuously in the clouds, and I was obliged to visit my Panglom station on three different days before I could get the angles I required. Here Faida Ali had an attack of fever and five or six of the *khalásis* got dysentery or fever owing to the wet weather.

On the 30th May, we left Meungsi and marched to Theinni which place we reached on the 2nd June. I managed to keep up the triangulation in spite of our marches being longer than previously, one march being of over 20 miles, in the middle of which I had to go several miles off the road to visit a hill; it was an especially long day. About 26 miles from Theinni we came into the Myit-ngé valley within a very short distance of its source.

We followed this valley down to Theinni, where the river gets a fair size and is only just fordable in the dry season.

At Theinni (about 2,100 feet in elevation) I measured a small base, observed for azimuth, etc., and managed to connect my triangulation with the work brought up from Mandalay. Theinni is the Sawbwa's capital and we left him here: the village is about the ordinary size, with no palace, the Sawbwa simply living in a common bamboo and thatched hut, like the rest of the villagers. I found Maung San waiting for me here, having come across from Namkham in four days. We left Theinni on the 5th June and arrived at Lashio on the 6th, having been nearly eight weeks away from it. During the tour, Faida Ali worked very hard and I think did excellent work. I left him with three *khalásis* at Lashio for the rains and he will probably go out for small trips during the breaks and fill up his map. Daly, who had given us great help during the tour, I left at Lashio and I started for Mandalay with Willcock on the 11th. The rain was now coming down in earnest and it rained nearly all day. We reached Thibaw on the 14th, Maymyo on the 22nd and Mandalay on the 26th June.

On the 23rd and 24th I went up Chinitaung station and on the second day managed to see the flash of a heliotrope, which Major Hobday had arranged to be worked at Ava Tower station.

The journey down from Lashio to Mandalay was most uncomfortable, many of the men got sick and our baggage animals nearly all got sore backs, etc., owing to the continued wet. The temperature in the plains appeared very unpleasantly warm after the Shan States where we generally had it cool and always an agreeably cool night. I arrived in Rangoon for the recess on the 30th June.

MOGOUNG EXPEDITION.

Extract from the Narrative Report of MR. M. J. OGLE, *Surveyor, 2nd Grade, attached to the* MOGOUNG FIELD FORCE,—*season 1888-89.*

I left Rangoon for Bhamo on the 21st November 1888, and arrived there on the 4th December, Bapu Jadu with Khasia coolies and native establishment having preceded me. Unfortunately, after leaving Prome, cholera broke out among the Khasias, and before reaching Bhamo, 15 men out of a total of 61 were seized with it and died.

On arrival at Bhamo I called on the Deputy Commissioner, and he arranged for my visiting Loilung hill. I also interviewed the Station Staff Officer with the object of arranging for rations for my men, and to find out when the troops who were to proceed to Mogoung would leave Bhamo.

The Deputy Commissioner having kindly lent me a launch, Bapu Jadu and I with a small escort of police left Bhamo on the 7th December, landed at Thapaungbin on the same day, and arrived at Loilung on the 9th, when we immediately began clearing the hill. There was very heavy cutting to be done, and I knew that from the small number of coolies I had (15) I could not get it satisfactorily completed during the time at my disposal; consequently I asked the headman of the Kachin village, where I was encamped, to help me with coolies, stating that I would pay them, but he refused to aid me. Sufficient, however, of the hill was cleared to the east, and a number of points were observed in that direction. We left in the afternoon of the 11th for Bhamo, plane-tabling *en route*. After I had finished observations at Bhamo station, I arranged with the *Myook*, the Deputy Commissioner being away, to visit Lephung hill, but when the day on which I was to leave arrived, the Deputy Commissioner came in and said it was not advisable to go there at present, as the Kachins in that neighbourhood were unfriendly, and that later on a punitive force was to be sent into those hills; so I was obliged to abandon the trip.

The column was to have left Bhamo on the 16th December, hence my hurrying away from Loilung; but owing to some cases of cholera having broken out in the regiment which was to proceed to Mogoung, the departure was postponed. I, however, arranged to go up to Senbo, and left for that place on the 18th, arriving there on the same day. The next day I crossed the river and went up to a small hill on the opposite side and took a few observations and did some plane-tabling. On the 20th I marched with Bapu Jadu for Loilung, about 9 miles to the north of Senbo. Having spent a couple of days there in plane-tabling we returned to Senbo and waited the arrival of the column, which came in on the 28th. On the 31st December it marched for Mogoung and arrived there on the 4th January 1889. After two days' halt at Mogoung, during which time I went up to Omantoung and was busy in plane-tabling about, the column commanded by Captain O'Donnell crossed the Mogoung river and marched to Kamieng, arriving there on the 11th, Bapu Jadu route-surveying and I plane-tabling *en route*.

Here it was discovered that small-pox had broken out among the Goorkha police, and in consequence our departure from Kamieng to the Kachin hills was unavoidably postponed. Owing to this reason guards could not be supplied me to visit hills six or eight miles off, which I was anxious to do. Thus after all that could be done at Kamieng I was obliged to remain in enforced inactivity till the 30th January, when a force dropped down the Namkong river in boats with the view of attacking Hwetom, a village of the Lepé Kachin tribe. This gave me an opportunity of working in some of the country, which

I had also seen from Kamieng. After punishing the village we returned to Kamieng, arriving there at midnight. On the 1st February another little excursion was made on the same village, but by another route, and nothing more was done till the 10th, when a fighting party marched on Seên, another Lepè village, after destroying which it returned again.

On the 14th February, when small-pox seemed to have subsided, the column crossed over the river, and on the next day marched for the hills inhabited by the Lepè tribe of Kachins. On the 15th we marched back along the Mogoung road in the plain, and on the 16th we entered the hills. We passed through two villages without encountering much opposition, burnt them, went on and camped at Paokaw. On the 17th Captain O'Donnell advanced on Paowela, while I retraced my steps to some fields we had passed through the previous day. Just as I returned to camp orders were received for the rest of the column to join the advance party. It had met with rather a determined opposition, but there were no casualties on our side. We were obliged to stop at Paowela, only 2½ miles from our last camp, as the guide could not hit off the track to Thama's village.

On the 18th February the column again marched in two detachments, as strong opposition was expected. However, we had a peaceful march down to the valley of the Tanaiku. On the following morning we marched early for Thama; this was the principal offending village of the Lepè tribe, and the chief whose name it bore was the main instigator of the work of these Kachins. The guide knew the direct path to the village, but expecting determined opposition and knowing that stockades existed on that path, he endeavoured to get round and take the enemy in flank; in this he failed, as the appearance of the country had changed since he had been there last; so there was no help for it, but to push straight on. When we were about a quarter of a mile from the village the advance force was fired into, and three men of the Hampshire dropped wounded. Captains O'Donnell and Macdonald were badly *panjeed*, besides several of the men. The stockade was rushed, and the village entered, but as usual not a soul was in it. A plane-table fixing in the village and another on the way back enabled me to fill in a considerable amount of new ground.

The 20th February was a rainy day, and in consequence a short march was made and a detached party sent off out of the line of march to destroy a village. What might have turned out a most serious matter, *viz.*, the loss of our guide, occurred on the morning of the 21st. The *Myook*, who was a Shan, with his followers and the guide, notwithstanding strict orders given to the contrary, slept in a hut outside the line of sentries (we were camped on low hills in a field). It had been raining during the night and evening, and they were too lazy to build for themselves. At 2 o'clock in the morning the hut was stealthily entered by Kachins, and all with the exception of the *Myook* and another were fearfully hacked about with dahs and one man killed. It was with difficulty that the guide could be induced to show us the road at daybreak; he was badly cut in the cheek and one of his hands dreadfully hacked. However, after stimulating him well with brandy, he was put into a dooly, and under a strong escort consented to point out the way. He was the only man to be found that could show us the way through the Lepè country, and Lieutenant Eliott, the Political Officer, had considerable difficulty in getting him. At the crossing of the Tanaiku the Kachins had taken up a strong position on the opposite bank, which was a cliff, and built a stockade there. The moment we appeared on the bank they opened a heavy fire on us, and a gunner was shot almost immediately; he died a few hours after. The men rushed through the stream, while the guns played on the stockade; it was soon taken and the column advanced on to the village of Muklon. This place likewise had a stockade, not in front but at the back of the village and just outside it, and seasoned bamboo spikes (*panjees*) were studded about. A British officer was badly wounded in the thigh with one of these while rushing through the village on to the stockade. He died about three weeks after, while undergoing an operation at Bhamo.

After burning Muklon we proceeded on and camped about a mile from the village of Kumongyi, that is, those who did come in; nearly the whole of the transport and rear-guard were obliged to halt along the line of road, night having overtaken us, and did not get in till next morning. Our astute guide, though so severely wounded, had his wits about him. There was an easier and more frequented road to Kumongyi; he suspected it to be well barricaded and anticipated much opposition, but outflanked the enemy by choosing the alternative route. As all had been without food the night previous, Captain O'Donnell decided upon remaining at this village to enable the men to cook and eat. After having done this a fighting party was sent to Naikumgyi, 1,800 yards across a valley as the crow flies, to destroy it and return at once. It turned out to be fortunate that the decision to remain where we were had been arrived at; for, shortly after leaving the village, the party was attacked from hills overlooking the road, and it was badly blocked up by trunks of felled trees. The transport and sick and wounded, had they been with the column, would have hampered its movements. This force after dislodging the enemy from point to point proceeded on to Naikumgyi, burnt it, and returned to camp. On the 23rd we marched through this burnt village, and after leaving Kumongyi our rear-guard was persistently attacked by the Kachins. One Sikh policeman was mortally wounded. Having passed through Naikumgyi no further opposition was met with, and we were out of the hills in the afternoon and camped in the Nampoung chaung. On the 24th the sick and wounded were taken into Mogoung and transport animals sent in to bring out rations. They returned on the 28th February. During this time I was employed in inking up and shading my plane-table.

On the 2nd March we surprised the village of Wananyong and proceeded on to Kadon. At the latter village they were well prepared for us, and had determined to strenuously oppose us, judging from the strong stockade they had built and obstacles they had thrown across the path. But being completely surprised at our taking them in rear, they showed little fight; notwithstanding, they succeeded in wounding two Goorkha policemen. We got back to camp that evening after doing a good day's work, both as to survey and objects of the expedition.

On the 4th we marched and camped at Nwenni Sakaung. On the 5th a small party of Goorkhas under a native officer was deputed to attack the village of Koungba, a short distance off. On their return we marched and camped on the left bank of the river opposite Mogoung.

On the 6th March we proceeded up the river by boat; this gave us the opportunity of surveying it up to the point where we had left off on our way down from Kamieng. On the 8th the villages of Pontu and Kawagoung were attacked, and on the 10th we were back again at Mogoung. The destruction of the two last-named villages completed the expedition against the Lepè tribe of Kachins. As far as the survey was concerned, this expedition resulted in the mapping of all the country inhabited by that tribe.

On the 11th March we were again on the move and marched for the hills inhabited by the Ithi tribe of Kachins, and made Nyaungbintha, on the right bank of the Namyin, our headquarters, from which place we operated against the offending villages, arriving there on the 13th. On the 14th the village of Hmsmat was attacked and burnt. On the 15th we marched for Longpu, considered to be the stronghold of the Ithis, but the guide played us false. He took us by an old disused path which eventually ended in no path at all, and after cutting our way for some distance, came under a cliff which could not be turned, so we were obliged to retrace our steps to camp. The next three days we remained in camp building a stockade, and on the 19th made another start for Longpu. Again, we were taken by a wrong road: the first time the guide tried to take us by a short cut; this attempt was by a circuitous one. We however reached Longpu before noon. The village was situated on a knoll, and a steep bit of hill had to be climbed to get to it; near the top of the knoll were a number of small stockades, and below it trees were felled to block the path. Some little opposition was offered, but it was soon overcome, the village entered and burnt, and we returned to camp (striking the direct road on our way back) after a long and arduous day's work. A good deal of new work was secured on this march, and a connection made with that brought up from Senbo.

On the 21st March two parties were sent out, one for Mansien and the other for Hwetom. The ground gone over had already been sketched, so only a route survey had to be made. The parties met and returned to camp together. On the 22nd the Hampshire commanded by Captain Macdonald left us to return to Bhamo. The column was detained till the 27th building a stockade, as a post had to be established there. On the 28th the column marched on Panga and two other villages close by, after destroying which it proceeded to camp near Nampadoung. We arrived at Mogoung on the 29th. This terminated the expedition against the Ithi tribe of Kachins, and resulted in the survey of all the hills occupied by that tribe.

On the 1st April we started on the third expedition, *viz.*, against the Sana tribe of Kachins, and on the 4th arrived at Panlang, which was just one long hut, but the property of the chief of that tribe, who is a great cattle-lifter and robber. The people evidently did not expect us till probably just the day before we marched into this village, for we surprised a gang of them busily engaged in making a stockade at the head of a very nasty gully through which the road went. They were flanked from two sides and fled. We entered this place without opposition; but continuing our march onwards, and when we had gone about 300 yards, half a dozen shots were suddenly fired at us from behind a stockade which had been newly made, and immediately after those behind it disappeared. They were followed up for a couple of miles when we came upon their fields, destroyed the granaries and huts that were there, and returned to camp. We were back again in Mogoung on the 6th. A large area was surveyed in the week that the column was out on this expedition and 98 miles of ground covered. A deal of sickness, however, resulted. This, I believe, was owing to the nature of the country we were then in, *viz.*, low hills rising from 1,000 to 1,800 feet high, covered with dense forest and thick undergrowth, and in which a heavy downpour of rain fell at our last camp during the night, when every body got wet through, and this was followed next day by a tremendously hot sun.

On the 10th April the column marched for Senbo, provisions and sick being taken down by boat. I availed myself of the opportunity of going down by boat with the object of surveying the river, and this was successfully done. The boat party arrived at Senbo on the evening of the 14th and the column on the morning of the 15th. It was decided to halt at Senbo for some days to give the men a rest and arrange to send down the sick to Bhamo, as the constant knocking about and the last five days' heavy marching, now that the weather was getting very warm, began to tell on them.

On the 20th April we were again on the move. The tribe of Kachins inhabiting the hills to the west of Senbo were to be visited. On the 21st the first village we came upon was Makan. We were opposed a couple of miles from the village, and as the enemy were driven from their post, they attacked the baggage animals and rear-guard, wounding a muledriver. A policeman was also wounded at Makan. We halted here for a couple of hours, during which time I made good use of my plane-table, after which a fighting party

started for Pinzon, three miles further on. Unfortunately I could do no work from this place, as the village was situated in a hollow and there was jungle all round. We returned to Makan, burnt it and another village close by, and thence marched on for Malwè. The path on leaving the village was very good, but after going a short distance it gradually began to get less defined until it was altogether lost in the jungles. We got benighted in the endeavour to find water, and had to clear a space for the camp in the dark as best we could and away from water. On the 22nd we arrived at the Namsaung chaung, only about a mile from our last night's bivouac, and made our camp in the flat open fields there. After breakfast we started for the village of Malwè, situated on a fine open spur; the path was stockaded in several places, but the people only held one, just at the entrance of the village. The moment we came in sight of it the enemy opened fire on us. The mountain battery had a good opportunity of displaying itself, and it certainly took advantage of it. In a very short time the stockade was cleared of the enemy, and a few men advancing under the cover of the guns found the village, when they entered it, altogether deserted. We then marched on Lwèkyo, two miles further up the ridge. This village commanded a fine view of the Kyawkkwè valley and the hills beyond, but no time could be spared to permit me to set up my plane-table, for almost immediately on entering Lwèkyo it was burnt and the troops retraced their steps for camp. On the 23rd we returned to Senbo in a pelting shower of rain. On the 26th April the villages of Mansin and Sakan were visited and destroyed, and the force got back to Senbo the same day. Another halt of four days again was given, in order to get up reinforcements from Bhamo to relieve the sick, which had increased considerably in numbers.

On the 1st May we were again ready for a start, and proceeded for the villages lying to the south of Senbo, four in number. Our first day's march was all along the plain for 10½ miles; the next was a short one of 6 miles, but over bad ground,—the whole way along the bed of a stream, and towards the end of the march through rain. Lwèpin, a village which should have been negotiated, escaped punishment. On this march the path which led to it was cleverly hidden by trees and bushes which the people had cut down, and hence escaped the guide's detection. On the 3rd we were again in the hills and burnt the villages of Kawan and Assin after a slight resistance. On the 4th a fighting party marched on Kachaing. It was allowed to enter the village with just a few desultory shots being fired, but on its return to camp it was most determinedly attacked from all sides, the advance, hospital and rear-guard were all fired into. Our casualties, however, were only three men wounded. On the return of the fighting party, we marched and camped on the Mozit chaung.

On the 5th May we passed through the village of Ponsi, not, however, without apprehending coming to hostilities with the people. As there was no cause for quarrel with this village, it was desirable that we should go peacefully through, which fortunately we did. There were a number of men in the village all armed with muskets. The head man accompanied us down to Pulaung, situated on the right bank of the Irrawaddy. I set up my plane-table at the village and at one or two points along the road. This day closed the expedition against the offending tribes of Kachins, for whose punishment the force was organised and the Mogoung column ceased to exist.

My party and I arrived at Bhamo on the 8th May. I took a few theodolite observations there, while Bapu Jadu carried a route survey to Sikaw. On his return to Bhamo we left by steamer for Mandalay on the 17th, left that place on the 23rd and arrived at Rangoon on the 24th May.

The result of our season's operations was some trifling triangulation to the east and north of Bhamo, a few points being fixed in the Kachin hills; 3,400 square miles of topography on ¼-inch scale; 64 linear miles of route survey by myself, and 420 linear miles of route survey by Bapu Jadu. Circum-meridional observations for latitude were also taken to north and south stars at five different places.

The country over which the survey extended was in portions flat, covered for the most part with forest and intermixed with patches of grass jungle. But the greater proportion of it was hilly and likewise forest-clad. The hills range from 1,500 to about 5,000 feet above sea-level, but the highest elevation attained by us was Thama's village 3,000 feet, and none of the Kachin villages in the whole of the tract surveyed exceeded this elevation. It may be said that they were situated at heights varying from 1,000 feet to 3,000 feet above sea-level; a few were as low down as 700 feet.

There are very few villages in the plains; those that do exist are inhabited chiefly by Shans. The soil is very rich for the cultivation of rice, and two harvests during the year is a common thing. The Kachins for the most part cultivate in the hills, in the same style as the Nagas and other wild hill tribes in Assam do, but some villages have their rice-fields in the plains also, and possess buffaloes for ploughing purposes.

The roads everywhere are excellent, and were suited for mule and pony transport. Very few places in the hills had to be cut and trimmed to render them practicable for the animals.

The rivers of note are the Mogoung (called Namkong also by the Shans), the Endaugyi, which joins it at Kamieng, and the Namyin. The former is navigable all the year round by big boats up to Kamieng, and the Endaugyi as far as the lake of the same name. During the rains small steam launches can ply the whole way up also. The Namyin I believe is navigable for small country boats, but only during the rains. Two other rivers, the Tanaiku and Namsongpi, attain considerable dimensions after their junction, and flow north into the Hukong Valley joining the Turongkong there.

REVISED SKETCH MAP
OF
THE COURSE OF THE SANGPO
93°
94°
95°
96°
97°
30°
29°
28°
Aladu Glaichag
Tsangla Jong
Demu Chamdo
Pok-Tsilung
Shawa Phodang?
Yamdo
Marpung Ky.
Gartung Ky.
Rongtung Ky.
Lhasa
Shiuben Ky
Kim Jong
Yeuri of G. M. N
Lo Chu
Yangtsang Chu
Tsangpo
Dikrung
Rangs Ky
Lhasa to Kamba Jong
Lhasa to Phari Jong
Lhasa to Kamba Jong
Lhasa to Gyangtse
Lhasa to Shigatse
Lhasa to Yamdo
Lhasa to Chetang
Lhasa to Tsetang
Lhasa to Lhoka
Lhasa to Lhoka
Lhasa to Lhoka

Excepting at the beginning of the season, which commenced with an epidemic of cholera among the Khasia coolies, during which time many deaths occurred, the party kept very good health, till again in April the heat and rain caused some sickness. Besides the deaths reported from cholera, two others occurred at the close of the season; but these were due, not from disease contracted in the field, but from natural constitutional debility and weakness from the time of enlistment at Shillong. Fever and diarrhœa were the chief causes of complaint among the rest, but to no serious extent. Bapu Jadu suffered a good deal for about a fortnight after our return from Sana, and was utterly incapacitated for work during that time. He recovered and did good work, while the column was operating against the tribes near Senbo and fell ill again when on his way to Sikaw.

In conclusion I have to thank Captain O'Donnell for the assistance he always rendered in supplying me with guards, &c., on occasions when they were required and could be spared, and Mr. Eliott also, the Political Officer, in obtaining guides, and kindly helping me whenever I asked him in translating for me and obtaining village names, &c. I am much indebted to both these officers for all the aid I have received from them.

Trans-Frontier Explorations.

Notes by Sub-Surveyor R. N. *on the country bordering Eastern Assam from information obtained during season 1888-89.*

While employed under Colonel H. C. B. Tanner, S.C., Deputy Superintendent, in charge No. 18 Himalaya Party, I was ordered to accompany Mr. Needham, Political Officer at Sadiya, on a journey up the Sangpo river.

I left Simla on the 12th November 1888 and reached Calcutta on the 18th, after which I proceeded to Náthán̆g (Gnatong) in Sikkim, according to the Surveyor-General's orders, to obtain information from Lama U. G. regarding South-East Tibet.

Such information as I received from the Lama I plotted on a copy of A. K.'s exploration map, which is now with Mr. Paul, the Deputy Commissioner of Darjeeling.

After finishing the above work I left Náthán̆g for Calcutta, where I arrived on the 11th of January 1889.

On the 15th January I left Calcutta for Sadiya by the orders of the Surveyor-General, being accompained by a guide named Kintup (Explorer K. P.), whose journey down the lower Sangpo was reported on by Colonel Tanner in the Annual Report for 1886-87. I arrived at Dibrugarh on the 28th of January and applied for assistance to the Deputy Commissioner, Lakhimpur, who referred me to Mr. Needham.

Leaving Dibrugarh on the 30th, I arrived at Sadiya on the 31st January 1889. Next day I went to Mr. Needham for orders and assistance for the proposed journey up the Sangpo and to the Mishmi hills. He told me to wait till a reply was received from the Chief Commissioner, Assam, to whom he had applied for permission to make a trip into the Mishmi hills. I had to wait at Sadiya till the 4th March; during my stay I took a few observations from a trigonometrical station and sketched the country round Sadiya.

Mr. Needham's journey not being thought advisable on political grounds, the object of my deputation failed, but during my stay at Sadiya, I obtained the following notes on the country bordering Eastern Assam, chiefly from Abor and Mishmi travellers whom I met at Sadiya:—

Route No. 1 from Sadiya to Pemakoichhen *viâ* Dhamro Padam and Shimong.

Towards the north and two days' journey from Sadiya, there is a village called Bamjor, situated on the right bank of the Dibong river. At a distance of about half a day's journey from Bamjor towards the west there is a village named Shiluk, which is on the right bank of the river Sesiri*. In a southerly direction, half a day's journey from Shiluk, is Mebo; from Mebo at the same distance and in the same direction is a village called Komkua. At a distance of about seven miles from Komkua towards the south-west, a river called Seku has to be crossed, beyond which, about four miles towards the west, is a village called Ayeng. Towards the north-west of Ayeng is another village called Duku, distant one day's journey and about six miles east of the junction of the rivers Sangpo and Yangsong† or Yam-ne.

* Sesiri by Upper Assamese. Shishar by Mishmis.

† Yangsong by the people of Pemakoichhen. Yam-ne by Abors. The river Yam-ne is as large as our great Rangit in Sikkim.

Towards the north of Duku after crossing a stream, Passe, situated about two miles from the left bank of the Yam-ne, is reached in one day.

Continuing towards the north, Dhamro Padam‡ is one day's journey. It lies at a distance of about three miles east of the river Yam-ne and west of the Regam range, and is not on the left bank of the Sangpo as reported by K. P.

‡ Dhamro Padam by Mishmis and Abors. Miri Padam by K. P.

The Bor Abors call Dhamro Padam, Peirten Permi, which means one of the capital villages among the Bor Abors. It is a locality numerously dotted with houses, and inhabited by Abors, to which the people of Pemakoichhen and Zyul, together with Miris and Mishmis, come for trade, &c.

There is a short cut from Dhamro Padam to Shiluk, across the Regam range. After crossing a cane bridge on the Yam-ne river, Miláng and Onlet villages are reached in half a day's journey from the bridge over the Yam-ne. The river Yam-ne has two sources, the eastern one of which drains Zyul Ted, and the other branch, the eastern Pemakoichhen country. The western is called Yangsong Chhu, and the other Zyul Chhu, the united branches being called Yam-ne by the Abors.

One day's journey to the north of Onlet, a village called Darpin* or Tarpin is met with, situated on a slope.

* Darpin by Abors. Tarpin by K. P.

Towards the west, distant also one day's journey, a village called Gobuk† or Mabuk, is met across a stream which joins the Yam-ne. From Mabuk after crossing a low pass, the large village of Shimong is reached. The range between Shimong and Mabuk is a branch apparently from the Yangsong Neh snowy peak and trends towards the south; the altitude is inconsiderable.

† Gobuk, by Abors. Mabuk by K.P.

Shimong is inhabited by Abors and is situated on flat ground at a distance of about five miles from the Sangpo river which lies to its westward.

Pemakoichhen is situated about five days' journey from Shimong towards the north-west. Pemakoichhen forms the boundary between the Abor country and Tibet. The tract of southern Pemakoichhen is inhabited more by Chingmi tribes than Tibetans, which fact I heard verified when in eastern Bhutan. The Abors call the Chingmis, Monba.‡ They come several times yearly to Shimong.

‡ Monba signifies lowlanders.

After crossing a cane bridge on the Sangpo river to the west of Shimong, Karkua village on the right bank is passed at a distance of eight miles, but the road to Pemakoichhen lies up the left bank to Keti or Geti, about four days' journey from Pemakoi.

To the south of Karkua a road leads along the right bank of the river Sangpo for four days' journey when a village called Pá-ling is met with, situated above the junction of the Sangpo and Shi-máng rivers; between Pá-ling and Karkua there are three villages, *viz.*, Pang-káng, Riga and Pá-rong. The river Shi-máng rises towards the west and flowing eastward joins the Sangpo near Pá-ling.

Route No. 2 down the right bank of the Sangpo from Karkua to Romkong and Sadiya.

After three days' journey towards the south from Pá-ling, Ke-báng village is reached; it is situated at the junction of the Seeom and Sangpo rivers; between Pá-ling and Ke-báng there are three villages, *viz.*, Rolging, Mo-pid and Shi-shen. The river Seeom rises in the west, and, flowing towards the east, joins the main river near Ke-báng.

After crossing a cane bridge over the river Seeom, there is a village called Ru-tung, which is on the right bank of the river Sangpo and opposite Pangie. The Sangpo is spanned by a cane bridge between these two villages. Pangie is situated at a distance of about two and a half miles from the junction of the Sangpo and Yam-ne. And towards the east, after crossing a cane bridge over the Yam-ne, the village of Duku (mentioned in Route No. 1) is met with.

About one day's journey towards the south-east of Ru-tung and across the low Riga range, a village called Romkong is situated on the southern slope.

The abovementioned stages are tabulated in the routes given below.

In the panoramic view seen from Sadiya the following details of geography can be traced:

The Dihong§ river could be clearly seen at a distance of about 40 miles, and seems to lie at a lower elevation than the Dibong valley.

§ Dhang by Upper Assamese. Shiang by Abors and Mishmis.

The slopes are entirely covered with various kinds of forests; any one ascending the Riga range could obtain much information. I heard that there is a lake in the midst of the range surrounded by forest.

The Regam range is also visible from Sadiya, but other ranges obstruct the view towards the Sangpo valley.

People pointed me out the direction of Dhamro Padam or Miri Padam, the magnetic bearing of which I found to be 326° from Sadiya. It is situated beyond the peaks whose heights are 9,100 and 8,010 feet on the range which slopes down from the north and forms the water-shed between the Yam-ne and Sesiri rivers.

As for the details of the Dibong‖ valley, I did not get any information and cannot say where it rises. People say that the rivers Yam-ne and Lohit rise from the same range in Zyul.

‖ Dibong by Upper Assamese. Sekang by Mishmis.

In my opinion if two or three inhabitants of Upper Assam, able to read and write, be taught route-surveying, the geographical details can be easily obtained, as the Assamese journey up the Sangpo for trade.

Routes from SADIYA *to* PEMAKOICHHEN *along the left bank of* SANGPO *river viâ* DHAMRO PADAM *and* SHIMONG.

Names of villages and stages.	Number of days.
Bamjor	2
Dambuk*	½
Shiluk	½
Mebo	½
Komkua	½
Ayeng	1
Duku	1
Passe	1
Dhamro Padam or Miri Padam	1
Miláng and Onlet	1
Darpin or Tarpin	1
Gobuk or Mabuk	1
Shimong	1
Gongko	½
Geti or Keti	½
Pá-ling	½
Ricol or Rikar	½
Puging	1
Shobang	1
Hanging	1
Shinging	1
Angi	1
Satong	1

Routes from SADIYA *viâ* ROMKONG *to* MIMA *in* PEMAKOICHHEN *along the right bank of* SANGPO *viâ* RIGA *village.*

Names of villages and stages.	Number of days.
Mong-ku	3
Romkong	½
Yonku	½
Ru-tung	1
Ke-báng	1
Shi-shen	1
Mo-pid*	1
Rolging	1
Pá-ling	1
Pá-rong	1
Riga	1
Karkua	1
Yu-ying	1
Ke-ráng	1
Bo-ria	1
Mima or Dangam	1

* It is not clear whether these villages are on the route or off it; from the map it would appear that they are not on the route.—G. S.

DRAWING OFFICE, CALCUTTA.

SECTION I.—GEOGRAPHICAL DRAWING AND COMPILATION.

Statement showing the work performed during the year 1888-89.

TITLE.	Number of Sheets.	Scale.	REMARKS.
Atlas of India.		In. M.	
Sheets Nos. 21 N. W., 21 N. E., 21 S. W., 21 S. E., 23 N. E., 24 N. E., 29 S. E., 31 N. E., 35 S. W., 36 N. W., 36 S. W., 40 N. W., 48 N. E., 48 S. E., 50 N. W., 68 N. E., 87 S. E., 89 N. E., 89 S. E., 104 N. W., 104 S. W.	21	1 = 4	Additions to outline and names for engraving.
Sheets Nos. 11 S. E., 22 N. E., 35 S. W., 57 N. W.	4	1 = 4	Hills brush-shaded for engraving.
Sheets Nos. 49 S. E., 49 N. W., 50 N. E., 51 N. E., 69 N. W., 69 S. W., 70 N. W.	7	1 = 4	Additions to railways, canals, and changes in boundaries.
Sheets Nos. 14, 15, 16, 18, 19, 48, 55, 59, 113, 114.	10	1 = 4	Ditto ditto ditto. Full sheets.
General Maps.			
India. Engraved	6	1 = 32	Additions to date
Do. do.	4	1 = 64	Do. do. } Extended to include Baluchistan and Burma.
Do. do.	2	1 = 80	Do. do.
Do. do.	1	1 = 96	Do. do.
Do. do.	1	1 = 128	Additions to railways to January 1889.
Do. do.	1	1 = 256	Outline completed. New edition.
Do. Lithographed	6	1 = 32	Second edition; completed.
Do. do.	6	1 = 32	Revised and extended to include Baluchistan; in progress.
Do. do.	6	1 = 32	Railway map.
Do. Skeleton	4	1 = 48	} Extended on east to include Burma and on west to include Baluchistan.
Do. do.	2	1 = 64	
Do. do.	4	1 = 48	} With hills: in progress.
Do. do.	2	1 = 64	
Burma and adjacent countries	2	1 = 32	Outline completed and press order given.
Do. do.	2	1 = 32	With hills: in progress.
Afghanistan	4	1 = 24	Completed.

DRAWING OFFICE, CALCUTTA.

SECTION I.

Statement of Work—continued.

TITLE.	Number of Sheets.	Scale.	REMARKS.
		In. M.	
Provincial Maps.			
Bengal	2	1 = 16	Additions to date.
North-West Provinces and Oudh	2	1 = 16	Compilation completed : is being engraved.
Assam	1	1 = 16	Corrected and press order given.
Mysore State	1	1 = 16	Changes in boundaries made.
Rajputana	2	1 = 16	Additions to date : in progress.
Upper Burma	1	1 = 16	4th and 5th editions corrected and press order given.
Divisional Maps			
Bhagalpur	2	1 = 8	Finished and press order given.
Rajshahi	2	1 = 8	In progress.
Dacca	2	1 = 8	Ditto.
Patna	2	1 = 8	Ditto.
Pegu	4	1 = 4	Lithographic print touched up and strengthened for use as an original.
District Maps.			
Manbhoom	...	1 = 4	Roads and boundaries corrected.
Singhbhoom	...	1 = 4	Boundaries corrected.
Patna	...	1 = 4	Roads and boundaries corrected.
Sonthal Pergunnahs	...	1 = 4	Ditto ditto.
Chumparun	...	1 = 4	Press order given.
Sibsagar	...	1 = 4	Ditto.
Hazaribagh	...	1 = 4	Ditto.
Durbhunga	...	1 = 4	Ditto.
Chanda	...	1 = 4	Ditto.
Rungpore	...	1 = 4	In press for proof.
Sarun	...	1 = 4	In press for proof.
Dinagepore	...	1 = 4	Ditto.
Mozufferpore	...	1 = 4	Ditto.
Bhagalpur	...	1 = 4	Ditto.
Standard Maps.			
MYSORE— Sheets Nos. 1 to 70	70	1 = 1	Changes in boundaries and additions to roads and railways.
CENTRAL INDIA AND RAJPUTANA— Sheets Nos. 387, 388, 403	3	1 = 1	Inserted railway.
CENTRAL PROVINCES— Sheets Nos. 4, 7, 8, 9, 10	5	1 = 1	Ditto ditto.
BOMBAY— Sheet No. 8	1	2 = 1	Re-drawn a portion from later Survey. Press order given.
Sheets Nos. 102, 118, 123, 190	4	2 = 1	Completed heading, foot-notes, references, &c. Press order given.
Sheets Nos. 5, 77, 109	3	1 = 1	Inserted railways.
LOWER BURMA— Sheets Nos. 179 $\frac{S.W.}{4}$, 180 $\frac{S.E.}{2}$	2	4 = 1	Inserted railways and completed foot-notes. Press order given.
UPPER BURMA (N.E. TRANS-FRONTIER SERIES)— Sheets Nos. 14, 15, 23	3	1 = 8	In progress.
Sheets Nos. 14 S.E., 22 S.W.	2	1 = 4	Do.
UPPER BURMA (S.E. TRANS-FRONTIER SERIES)— Sheets Nos. 3, 3*a*, 7, 8	4	1 = 8	Nos. 3, 3*a*, and 7 in progress. No. 8, Press order given.
Sheet No. 1	1	1 = 8	Addition to compilation of Baungshi Country heading, foot-notes, references, &c., finished. Press order given.
Sheets Nos 1 N.E, 3rd Ed., 1 S.E., 3rd Ed., 2 N.E., 4th Ed., 2 S.E., 2nd Ed., 4 N.W., 3rd Ed., 4 N.E., 4 S.E, 5 S.E., 5 N.E.	9	1 = 4	Heading, foot-notes, references, &c., finished. Press order given.

DRAWING OFFICE, CALCUTTA.

SECTION I.

Statement of Work—continued.

TITLE.	Number of Sheets.	Scale.	REMARKS.
Standard Maps—contd.		In. M.	
N.W. TRANS-FRONTIER SERIES—			
3 Maps	3	1 = 4	Outline finished in Drawing Office, Calcutta. Sent to Dehra for hills and addition of new work.
1 Map	1	1 = 4	Eastern half finished, with hills, in Drawing Office, Calcutta. Sent to Dehra to complete the western portion.
4 Maps	4	1 = 4	Fresh work inserted and press order given.
2 Maps	2	1 = 4	Brought up to date.
4 Maps	4	1 = 2	Foot-notes and border completed and press order given.
6 Maps	6	1 = 2	Additions to canals, roads, &c.
4 Maps	4	2 = 1	Ditto. ditto.
Administration Report Maps.			
Punjab Province . . .	1	1 = 32	Railways and canals brought up to date. Press order given.
Ditto . . .	1	1 = 80	Railways brought up to date. Press order given.
North-West Provinces and Oudh	1	1 = 80	Ditto ditto. Ditto.
Bengal Province . . .	1	1 = 80	Ditto ditto. Ditto.
Assam	1	1 = 80	Ditto ditto. Ditto.
BENGAL— Rajshahi, Dinagepore, Pubna, Bogra, Jalpaiguri, Burdwan, Bankoora, Midnapore, Howrah, Beerbhoom, Hooghly, Hazaribagh, Manbhoom, Singhbhoom, Dacca, Lohardugga, Furreedpore, Backergunge, Mymensingh, Moorshedabad, Nuddea, Jessore, Khoolna, Maldah, 24-Pergunnahs, Bhagalpur, Purneah, Sonthal Pergunnahs, Monghyr, Noakholly, Chittagong, Tipperah, Balasore, Cuttack, Pooree, Darjeeling districts.	36	1 = 8	Additions to roads and canals.
NORTH-WEST PROVINCES AND OUDH— Bahraich, Sultanpur, Lucknow, Fyzabad, Hardoi, Sitapur, Gonda, Partabgarh, Rae Bareli, Lalitpur, Dehra Dun, Etah, Etawah, Gorakhpur, Moradabad, Cawnpore, Budaun, Aligarh, Muttra, Agra, Bareilly, Meerut, Mirzapur, Saharanpur, Shahjahanpur, Banda, Bijnor, Benares, Jhansi, Pilibhit, Mainpuri, Ghazipur districts .	32	1 = 8	Roads and canals inserted. Press order given.
PUNJAB— Muzaffargarh district and Patiala Native State . .	2	1 = 8	Roads and canals inserted. In press for proofs.
ASSAM— Sibsagar, Cachar, Darrang, Lakhimpur districts . .	4	1 = 8	Completed. Press order given.
RAJPUTANA— Ajmere, Merwara districts .	2	1 = 8	Ditto. Ditto.
Coorg	1	1 = 8	Ditto. Ditto.
Index Maps.			
India showing progress of Imperial Surveys . . .	1	1 = 128	Corrected to 1st October 1889.
The G. T. Survey of India .	1	1 = 96	Do. do.

DRAWING OFFICE, CALCUTTA.

SECTION I.

Statement of Work—continued.

TITLE.	Number of Sheets.	Scale.	REMARKS.
		In. M.	
Index Maps—contd.			
Survey Operations in Himalayas	1	...	Corrected to 1st October 1889.
Ditto Madras	1	...	Do. do.
Forest Surveys, Lower Burma	1	...	Do. do.
Ditto, Bombay (North Division)	1	...	Do. do.
Forest Surveys, North Kanara (South Circle)	1	...	Do. do.
Standard Sheets, Bombay Presidency	1	...	Do. do.
Standard Sheets, Central India and Rajputana	2	...	Do. do.
Standard Sheets, Assam	1	...	Do. do.
Ditto, Sind	1	...	Do. do.
Statistical Maps.			
India showing percentage of cultivated area of Cotton	2	1 = 64	15 Copies prepared by hand in tints.
Do. do. Rice	2	1 = 64	13 Do. do. do.
Do. do. Tobacco	2	1 = 64	34 Do. do. do.
Miscellaneous Maps.			
Ruby Mines	2	2 = 1	Additions, headings, foot-notes, borders, references, &c., finished. Press order given.
Ditto	3	6 = 1	
Country east of Chindwin river	1	1 = 16	Prepared for Foreign Department.
Lushai and adjacent Hill tracts	1	1 = 8	With additions. Press order given.
Pambar Reserved Forests	1	4 = 1	Heading, foot-notes, references, &c., finished in Drawing Office, Calcutta. Press order given.
India	2	1 = 64	Showing Provincial boundaries. Prepared for Revenue and Agricultural Department.
Do.	2	1 = 64	Showing different gauges of railways with table of reference. Prepared for Revenue and Agricultural Department.
Hastadand and surrounding countries	1	1 = 2	Hand-drawn in colours for General MacLean.
Road between Demagri and Howsata's villages	1	1 = 2	To illustrate Major Leach's Report on the Chittagong Expedition.
Andaman Sheets, Nos. 8 and 9	2	1 = 2	Tracing supplied to Marine Department.
Projecting and plotting Plane Tables	3	1 = 4	For use with Lushai Expedition.
Do. do. do.	3	1 = 4	Do. Chumbi Valley Expedition.
Chart of triangulation	1	1 = 4	Do. do. do. with Colonel Tanner's data.
Telescopic view of Kanchinjunga from Kosi	1	...	Prepared by Colonel Tanner; drawn and finished in Drawing Office, Calcutta. Press order given.
Telescopic view of Kanchinjunga from Debigunge G. T. S.	1	...	Ditto ditto.
Telescopic view from Kosi river station	1	...	Ditto ditto.
Telescopic view of Mount Everest and Peak XIII from Sandukphu	1	...	Ditto ditto.
WORK DONE FOR OTHER DEPARTMENTS.			
Bengal, Trade	1	1 = 16	Showing external trade routes in Sikkim, Tibet and Bhutan.
Do. Excise	1	1 = 80	Showing incidence of percentage on Opium.
Do. do.	1	1 = 80	Do. do. do. Ganja.
Do. do.	1	1 = 80	Do. do. do. Excise revenue.
Do. Emigration	1	1 = 80	Showing colonial emigration.
Do. do.	1	1 = 80	Showing registration of native districts of inland emigrants.
Do. Police	1	1 = 80	Showing cognizable crime.
Do. do.	1	1 = 80	Showing dacoity.
Do. do.	1	1 = 80	Showing minor offences.
Do. do.	1	1 = 80	Showing serious offences.
Do. do.	1	1 = 80	Showing civil litigation.
Do. Sanitation	1	1 = 80	Showing mortality from small-pox.

DRAWING OFFICE, CALCUTTA.

SECTION I.

Statement of Work—concluded.

TITLE.	Number of Sheets.	Scale.	REMARKS.
Bengal Sanitation	1	1 = 80	Showing mortality from cholera.
Do. do.	1	1 = 80	Showing mortality from fever.
Do. Crops	1	1 = 80	Showing price of rice in 1887-88.
Do. do.	1	1 = 80	Showing price of wheat in 1887-88.
Do. Income Tax	1	1 = 80	Showing incidence of taxation represented by number of persons assessed to each rupee.
Do. do.	1	1 = 80	Showing distribution according to net demand.
Do. Education	1	1 = 80	Showing extent of collegiate and secondary education.
Do. do.	1	1 = 80	Showing primary education.
Do. do.	1	1 = 80	Showing female education.
Do. do.	1	1 = 80	Showing Mahomedan education.
Do. Postal	1	1 = 80	Showing comparative postal operations and lines of telegraph.
Do. Soil	1	1 = 80	Showing character of soil.
Do. Rainfall	1	1 = 80	Showing rainfall during the year.
Do. Revenue	1	1 = 80	Showing percentage of land revenue.
Calcutta, Police	1	3 = 1	Showing police stations
N.-W. Provinces and Oudh, Emigration	1	1 = 80	Showing native districts of inland emigrants.
Punjab, Emigration	1	1 = 80	Ditto ditto ditto ditto.
Do. Trade	1	1 = 80	Showing external trade routes.
Province of Berar	1	1 = 16	Prepared for the Resident of Hyderabad.
Singhbhoom District	1	1 = 4	Entered sub-divisional boundaries and calculated areas of thanas for the Deputy Commissioner of Singhbhoom.
Persia, showing Telegraph lines	1	1 = 80	Prepared for Director-General of Telegraphs.
Telegraph routes to Great Britain	1	...	Ditto ditto ditto.
Chota Nagpore Division Survey, Sheets Nos. 1, 2, 3, 4, 6, 7, 8, 9, 13, 14, 15, 16, 17, 22, 23, 24	16	1 = 1	Inserted thana boundaries for the Deputy Commissioner of Singhbhoom.
Proposed Railway from Delhi to Kotri	1	1 = 64	To illustrate Mr. Horace Bell's report.
North-Western Railway	1	1 = 80	Coaching map for Director, North-Western Railway.
Do. do.	1	1 =150	Ditto ditto ditto.
India, Trade	1	1 =144	Illustrating the system of registration of inland trade by rail and river.

DESCRIPTION OF WORK.	Number of Sheets.
Maps examined.	
Atlas sheets	46
General maps	51
Provincial maps	14
Divisional maps	1
District maps	25
Standard maps	48
Index maps	9
Statistical maps	47
Triangulation charts	1
Miscellaneous maps	8
Maps prepared for other departments	3
Engraved proofs of General and Provincial maps	45
Engraved proofs of District maps	43
Engraved proofs of Atlas sheets in various stages	123
Lithographic proofs of General and Provincial maps, including Index Charts	25
Lithographic proofs of Atlas Sheets and District maps transferred from Copper-plates	16
Lithographic proofs of Extra-Departmental and Statistical maps	15
Photographic proofs of Standard Sheets, large scale plans, and various other maps	307
Colouring of maps for office use	18
Tracings of maps for various purposes	5
Work compiled in Geographical Examining Section	11
Proofs of Professional forms	6
Projection and examination of graticules and plotting of points	28
TOTAL	895

N.B.—In addition to the above, many miscellaneous jobs, such as supply of geographical data to various officials, calculation of areas, computation of graticules for the projection of the sheets of the Indian Atlas, examination of the proof-sheets of Survey of India Notes and of Narrative Reports of Survey Parties as to the correct orthography of names, &c., have been performed by the Examining Section.

DRAWING OFFICE, CALCUTTA.

SECTION II.—REVENUE.

Statement showing the work performed during the year 1888-89.

TITLE.	Number of Sheets.	Scale. In. M.	REMARKS.
STANDARD MAPS.			
Punjab—			
District Hissar.			
Sheet 256	1	1 = 1	Publication deferred pending insertion of canals from Executive Officer.
District Rawalpindi.			
Sheets 161 ($\frac{N.E.}{4}$, $\frac{S.E.}{1}$); 184 ($\frac{N.W.}{1,2,3,4.}$, $\frac{S.W.}{1,2,3,4.}$); 185 ($\frac{N.W.}{1,2,3}$ and $\frac{S.W.}{1}$)	13	4 = 1	First proofs examined and sent to press.
Districts Jullundur, Ludhiana, Hoshiarpur and Umballa.			
Sheet 253	1	1 = 1	Proofs passed; press order given.
Sheets 225, 226, 266, 267, 269, 290, 291, 292, 313 and 336	8	1 = 1	Proof passed; press order given.
Sheets 270 and 289	2	...	First proofs examined and returned to press for corrections.
Sheets 249, 293, 294 and 315	4	1 = 1	Examined and sent to press.
Sheet 227	1	1 = 1	Being completed up to margin.
Sheets 213 and 316	2	1 = 1	Examined; awaiting completion up to margin.
Sheets 271, 272, 273 and 274 (Patiala Portion)	4	1 = 1	Publication deferred on account of the survey of canals.
Sheets 291, 292 and 293	3	1 = 1	Returned to Executive Officer for completion.
North-Western Provinces—			
District Aligarh.			
Sheets 23, 36, 52 and 53	4	1 = 1	First proofs examined and returned to press.
Sheets 17 and 18	2	1 = 1	Press order given to meet a special demand made by the District Staff Officer of Meerut.
Sheets 23 ($\frac{N.E.}{S.E.}$); 36 ($\frac{N.W.\ N.E.}{S.W.\ S.E.}$); 37 (N.W.); 52 ($\frac{N.W.\ N.E.}{S.W.\ S.E.}$), and 53 ($\frac{N.W.\ N.E.}{S.W.\ S.E.}$)	13	2 = 1	First proofs examined and sent to press.
District Gorakhpur.			
Sheets 216 and 217	2	1 = 1	Press order given.
Sheets 207 and 208	2	1 = 1	Drawn, completed and sent to press.
Sheets 191 and 192	2	1 = 1	Drawing completed; under examination.
Sheets 190, 205, 206, 214 and 215	5	1 = 1	Drawing completed; accessory work in hand.
Sheets 189 and 213	2	1 = 1	Pentagraphed; typing in progress.
District Basti.			
Sheet 162	1	1 = 1	Published (preliminary edition).
Sheets 163, 173, 174, 175, 176, 191 and 192	7	1 = 1	Examined and sent to press.
Sheets 188, 189, and 190	3	1 = 1	Under examination.
District Mirzapur.			
Sheet 169	1	1 = 1	First proof examined and sent to press.
Sheets 170 and 171	...	...	Passed; press order given.
Sheets 182 and 197	2	1 = 1	Examined and sent to press.
Sheets 197, 198 and 199 (Chakia portion)	3	1 = 1	Being completed up to margin.
Oudh.			
Sheets 101, 103, 107 and 147	4	1 = 1	Passed; press order given.
Sheets 148, 149, 151, 152, 162 174, 175 and 192	8	1 = 1	Sent to press for correction.
Sheets 98, 99, 113, 163 and 192	5	1 = 1	Proof sent to District Officer for examination.
Bengal—			
District Cuttack.			
Sheet No. 196	1	1 = 1	Press order given.
Sheet No. 195	1	1 = 1	Proof sent to District Officer for examination.
Sheet No. 194	1	1 = 1	Proof examined and sent to press.
District Mymensingh.			
Sheets Nos. 344 and 364	2	1 = 1	Press order given.
Sheets Nos. 346 and 362	2	1 = 1	Proofs examined and sent to press.
Sheets Nos. 343 and 345	2	1 = 1	Proofs sent to District Officer for further reference.
District Hooghly.			
Sheets Nos. 4 and 6	2	1 = 1	Originals corrected up to date and proofs passed with press order to replenish stock.

DRAWING OFFICE, CALCUTTA.

SECTION II.

Statement of work—continued.

TITLE.	Number of Sheets.	Scale.	REMARKS.
		In. M.	
Bombay—			
Sheet No. 160	1	1 = 1	Publication deferred until a portion of Dharampur State is surveyed, when it will be sent to the field party for completion.
Sheet No. 243	1	1 = 1	Press order given.
Sheet No. 205	1	1 = 1	Examined and corrected.
Sheets Nos. 305 and 306	2	1 = 1	Proofs examined and sent to press.
Sheet No. 307	1	1 = 1	Originals examined and sent to press.
Burma (Lower)—			
Sheets Nos. 278 and 280	2	1 = 1	Original examined and sent to press; proofs passed, and press order given.
Sheets Nos. 142, 187, 234, 281 and 329	5	1 = 1	Originals drawn and sent to press; proofs received and sent to local officers for examination, with the exception of sheet No. 329.
Sheets Nos. 235, 236, 282, 283, 326 and 328	6	1 = 1	Drawing in progress.
Sheets Nos. 229 and 230	2	1 = 1	Being completed up to margin.
PLANS OF CITIES AND CANTONMENTS.			
Benares City, including Sikraul and Pandipur Cantonments	4	{ 8 = 1 / 6 = 1 }	Completed, sent to press, and proofs received.
Map of the Town of Calcutta	15	26·4 = 1	Thirteen sheets projected and plotted.
TRIANGULATION CHARTS.			
Preliminary Chart of Secondary Triangulation, District Akyab	2	1 = 4	Projected, plotted and sent to press; proofs received and passed; press order given.
INDEX MAPS.			
Survey operations in the Punjab	...	...	Corrected, brought up to date and sent to press.
Bombay Topographical Survey	...	...	Ditto ditto.
Guzarat do. do.	...	...	Ditto ditto.
Cadastral Survey in district Bilaspur	...	...	Ditto ditto.
Cadastral Survey in district Tarai	...	...	Ditto ditto.
Cadastral Survey in district Jhansi	...	...	Ditto ditto.
Cadastral Survey in district Sibsagar	...	...	Ditto ditto.
Cadastral Survey in district Thongwa	...	...	Ditto ditto.
Cadastral Survey in Srinagar Estate	...	...	Ditto ditto.
Cadastral Survey in Sankarpur Estate	...	...	Ditto ditto.
Cadastral Survey in Maldwar Estate	...	...	Ditto ditto.
Cadastral Survey in Kujang Estate	...	...	Ditto ditto.
Survey of the Town of Calcutta	...	...	Ditto ditto.
Traverse Survey in districts Nagpur and Wardha	...	...	Ditto ditto.
Traverse Survey in districts Seoni and Chhindwara	...	...	Ditto ditto.
Traverse Survey in districts Saugor and Narsinghpur	...	...	Ditto ditto.
Traverse Survey in districts Betul and Hoshangabad	...	...	Ditto ditto.
Cadastral Survey in district Jalpaiguri	...	...	Drawn and sent to press.
Cadastral Survey in district Chittagong	...	...	Ditto.
Cadastral Survey in Burdwan Khas Mehals	...	...	Ditto.
Cadastral Survey in Kanika Estate	...	...	Ditto.
Traverse Survey in district Lalitpur	...	...	Ditto.
Traverse Survey in district Chanda	...	...	Ditto.
Traverse Survey in district Bhandara	...	...	Ditto.

DRAWING OFFICE, CALCUTTA.

SECTION II.

Statement of Work—continued.

TITLE.	Number of Sheets.	Scale.	REMARKS.
		In. M.	
INDEX MAPS—*contd.*			
Traverse Survey in district Nimar	...	...	Drawn and sent to press.
Traverse Survey in district Balaghat	...	...	Ditto.
Proofs Examined.			
Photo-zincographed maps	191		
Lithographed maps	45		
Computations examined.			
District Gorakhpur, Seasons 1882-88.			
Traverse data, &c., supplied.			
Adegaon Jagir along the Jagir of Ghorpani			To Deputy Commissioner, Seoni.
Certain Bassein villages (4 pages)			To F. W. Kelly, Esq.
Certain Hanthawaddy villages			Ditto.
Henzada villages (88 pages)			To Deputy Commissioner.
Six villages of pargana Magoora			To Collector of 24-Pergunnahs.
Three villages of district Bhagalpur			To Collector.
Nine villages of district Pubna			To Collector.
Twenty-one villages of district Sonthal Pergunnahs			To Deputy Commissioner.
A group of Barabaju villages			To Collector of Pubna.
District Bassein, along district Thongwa			To F. W. Kelly, Esq.
Two villages of district Moorshedabad			To Collector.
Two villages			To Collector of Backergunge.
Two villages of old and new survey			To Collector of Patna.
Two villages of district Sarun			To Collector.
Two villages of district Ballia			To Collector.
Miscellaneous.			
Prepared Alphabetical Indexes of district Tarai, pargana Kashipur			To Colonel Sandeman.
Prepared areas remaining for Survey in the several provinces of India.			
Calculated co-ordinates of intersection points of districts Sirsa and Karnal for projection; also of (1′ corners) of the City of Calcutta.			
Calculated Latitude and Longitude for the Triangulation Chart of Akyab.			
Calculated areas by parganas of Sheets Nos. 194, 195 and 196 of district Cuttack; Sheets Nos. 52, 53, 169, 170, 171, 182, 197, 207, 208, 216 and 217 of North-West Provinces; Sheet No. 39 of district Kamrup; and Sheet No. 307 of Bombay.			
Prepared statement showing areas of Rivers in the Punjab.			
Revised the areas of all districts in North-West Provinces and Oudh.			
Prepared acre combs on 4″, 8″ and 20″ scales, and scale for calculation of height in a slope; also prepared 3 talc squares on 4″, 8″ and 16″ to the mile. Prepared 6 bigha scales according to local measurement.			
Computed and plotted a group of villages of Pargana Barabaju.			
Prepared area statement of the Chittagong Hill Tracts and of district Pertabgarh.			
Prepared statement showing areas of cultivation, waste, &c., &c., of the districts in Bengal			For Bengal Government.

DRAWING OFFICE, CALCUTTA.

SECTION II.

Statement of Work—continued.

DESCRIPTION OF WORK.	Scale.	REMARKS.
Tracings prepared.	In. M.	
Sheets Nos. 81, 82, 83 and 84, district Karnal.	4=1	For Executive Engineer, Western Jumna Canal.
Pargana Nathpur, district Bhagalpur.	4=1	For Collector.
Sheets Nos. 222 and 223, Adegaon Jaghir, district Chindwara	4=1	For Deputy Commissioner.
Village plan of pargana Bhagalpur, district Bhagalpur.	4=1	For Deputy Collector.
Five village plans of pargana Tollygunge and one of pargana Medanmal, district 24-Pergunnahs.	4=1	For Collector.
District Jalpaiguri, showing limits of survey and forests	1=4	For Colonel Cowan.
Two village plans of district Dinagepore.	4=1	For Settlement Officer, Sankerpore Estate.
Two village plans, district 24-Pergunnahs.	4=1	For Executive Engineer, C. and E. Canal Division, Writers' Buildings.
Twelve villages of district Dinagepore.	4=1	For Colonel Barron.
Village plan of pargana Dashmalan, district Balasore.	4=1	For Deputy Collector.
Portion of map No. XVI, Rennell's Atlas.	1=5	For Commissioner.
Reduced plan of portion of 1 map of M. C. Nos. 7 and 8, district Dacca, from Jafirganj to Jamalpur.	1=5	For Commissioner.
Boundary between district Jalpaiguri and Cooch Behar, season 1868-69.	4=1	For Colonel Cowan.
Mauza Jaswal, district Shahpur	4=1	For District Judge, Jhelum.
Two village plans of pargana Ruknpur, district Moorshedabad.	4=1	For Collector of Moorshedabad.
Boundary between district Jalpaiguri and Cooch Behar State, Season 1869-70 (2nd despatch).	4=1	For Colonel Cowan.
Village plan, pargana Soojabad, district Dacca.	4=1	For Collector.
Boundary between district Jalpaiguri and Cooch Behar State, Surveyed by B. H. Renney, Esq.	4=1	For H. T. Hanby, Esq.
Village plan of pargana Berahimpur, district Pubna.	4=1	For Deputy Collector.
Village plan of pargana Kagmari, district Pubna.	4=1	For Collector.
Four village plans of pargana Ballandah, district 24-Pergunnahs.	4=1	For Deputy Collector.
Two villages of pargana Fateh Jungpur, district Dinagepur.	4=1	For Colonel Cowan.
Portions of Sheets Nos. 17 and 19, district Goalpara.	2=1	For Deputy Commissioner, Garo Hills.
Mauza Balluwal, district Shahpur.	4=1	For District Judge, Jhelum.
Village plan, pargana Medanmal, district 24-Pergunnahs.	4=1	For Collector.
Eight villages of pargana Barabaju, district Pubna.	4=1	For Collector.

DRAWING OFFICE, CALCUTTA.

SECTION II.

Statement of Work—continued.

DESCRIPTION OF WORK.	Scale.	REMARKS.
Tracings prepared—contd.	In. M.	
Five villages of pargana Shergarh, district Manbhoom.	4=1	For Superintendent of Works.
Sheets Nos. 10, 14, 15 and 19, district Champarun, showing Gundak River (in duplicate).	4=1	For Conservator of Forests, Bengal.
Village plan, pargana, district Moorshedabad.	4=1	For Collector.
Town Suburbs of Soory.	8=1	For District Superintendent of Police.
Portion of Cooch Behar-Rungpore boundary taken from survey of both districts.	4=1	For Deputy Surveyor-General.
Village plan of pargana Chandradeep, district Backergunj.	4=1	For Collector.
Two village plans of districts Patna and Mozaffarpore and two of Ganges River Survey.	4=1	For Sub-Divisional Officer, Barh.
Village plan of pargana Sonabaju, district Pubna.	4=1	For Collector.
Map of eleven churs, district Noakhally.	2=1	For Legal Remembrancer, Bengal.
Sheets Nos. 10, 11 and 15 in Main Circuits 2 and 8, district Rungpore, showing boundary along district Goalpara.	4=1	For Deputy Commissioner, Garo Hills.
Three village plans of district Mymensingh, showing boundary along district Goalpara.		
Village plan of pargana Asadnagar, district Moorshedabad.	4=1	For Collector.
Maps of districts Kyaukpyu, Tharrawaddy, Bassein, Henzada, Hanthawaddy, and Prome, showing areas surveyed and proposed for survey (in duplicate).	1=4 1=8 1=12	For Deputy Surveyor-General (Rev.)
Patandi State, extracted from sheets Nos. 16, 17, 28 and 29 of district Gurgaon.	—	For Commissioner, Delhi Division.
Village plan of pargana Haveli, district Gorakhpur.	4=1	Colonel Sandeman.
Boundary demarcation of Jainte Deostan, district Jalpaiguri of Bhutan.	2=1	For Executive Officer, No. 4 Party.
Disputed land between Jalpaiguri and Bhutan.	—	
Disputed land between Jalpaiguri and Bhutan.	1=1	
Trans-frontier Skeleton Sheet No. 9, showing all the districts, parganas, thanas, &c., in the districts of Bengal and the North-Western Provinces and Oudh bordering on Nepal. Compiled from the 4-mile maps in office (in duplicate).	1=32	For Resident of Nepal.
Maps Coloured.	Numbers.	
Maps on various scales.	36	For Surveyor-General's Office.
Ditto ditto.	36	For Deputy Surveyor-General's Office.
Ditto ditto.	258	For India Office.

DRAWING OFFICE, CALCUTTA.

SECTION III.—CADASTRAL.

State of Publication of Cadastral Maps on the 30th September 1889.

DISTRICTS.	NUMBER OF SHEETS.							REMARKS.
	MAPS PREPARED.			PUBLISHED.				
	Up to 30th September 1888.	Added during past 12 months.	Total up to 30th September 1889.	Up to 30th September 1888.	By Surveyor-General's Office during past 12 months.	Total to 30th September 1889.	Remaining to be published.	
North-Western Provinces.								
Agra	2,942	...	2,942	2,942	...	2,942	...	
Azamgarh	930	...	930	930	...	930	...	
Ballia	1,396	...	1,396(b)	1,396	...	1,396	...	
Banda	3,317	...	3,317	3,317	...	3,317	...	
Basti	5,425	132	5,557(b)	2,501	859	3,360	2,197	
Benares	2,052(a)	...	2,052	1,884	168(c)	2,052	...	(a) Figures of previous return have been changed to agree with final results.
Bijnor	31	...	31	31	...	31	...	
Dehra Dun	701	...	701	699	2	701	...	
Fyzabad	...	14	14	...	14	14	...	
Ghazipur	3,391(a)	...	3,391(b)	3,193	198(c)	3,391	4142	(b) These figures are liable to alteration until publication has been completed.
Gorakhpur	8,427	...	8,427(b)	3,266	1,019	4,285	...	
Hamirpur	2,926	...	2,926	2,926	...	2,926	...	
Jaunpur	3,434	...	3,434	3,434	...	3,434	...	
Moradabad and Tarai	4,023	...	4,023	4,023	...	4,023	...	
Muttra	1,658	...	1,658	1,658	...	1,658	9	(c) These maps have been reprinted.
Mirzapur	3,648(a)	...	3,648(b)	3,639	...	3,639	...	
Tarai	409	...	409	346	63	409		
TOTAL	44,710	146	44,856	36,185	2,323	38,508	6,348	
Burma.								
Akyab	2,741	...	2,741	2,342	399	2,741	...	
Bassein	3,356	81	3,437	3,076	349	3,425	12	
Hanthawaddy and Pegu	4,601	...	4,601	4,601	...	4,601	...	
Henzada	1,391	...	1,391	1,391	...	1,391	...	
Prome	847	...	847	847	...	847	...	
Tharrawaddy	1,363	...	1,363	1,363	...	1,363	...	
Thongwa	...	979	979(b)	...	63	63	916	
TOTAL	14,299	1,060	15,359	13,620	811	14,431	928	
Bengal.								
Patna and Gya	3,054	...	3,054	3,054	...	3,054	...	
Pooree (Khorda Estate)	4,565	36	4,601	4,565	36	4,601	...	
Shahabad	4,924	...	4,924	4,924	...	4,924	...	
Mozufferpur	1	...	1	1	...	1	...	
TOTAL	12,544	36	12,580	12,544	36	12,580	...	
Assam.								
Darrang	717	...	717	703	...	703	14	
Kamrup	1,675	...	1,675	1,675	...	1,675	...	
Nowgong	...	449	449(b)	...	435	435	14	
Sylhet	61	...	61	16	...	16	45	
TOTAL	2,453	449	2,902	2,394	435	2,829	73	
Central Provinces.								
Raipur	43	...	43	43	...	43	...	
TOTAL	43	...	43	43	...	43	...	
GRAND TOTAL	74,049	1,691	74,740	64,786	3,605	68,391	7,349	

Abstract of work performed during 1888-89.

PROVINCES.	NUMBER OF SHEETS.				REMARKS.
	Examined and rendered suitable for photo-zincography.	Traced and examined for zincography.	Proof copies examined previous to press order.	Coloured and subsequently examined.	
North-West Provinces	1,922	574	2,419	2,323	Scale 16 inches = 1 mile.
Burma	587	124	831	811	Ditto ditto.
Bengal	...	36	36	...	Ditto ditto.
Assam	315	134	443	...	Ditto ditto.
TOTAL	2,824	868	3,729	3,134	

ENGRAVING OFFICE, CALCUTTA.

Statement showing the work performed during the year 1888-89.

Title of Map.	Outline. Square inches.	Number of letters cut.	Hills (H.), Sand (S.), Salt waste (S.W.). Square inches.	Remarks.
Indian Atlas.				
Scale, 1 inch = 4 miles.				
Quarter sheets (new), completed				
15 N. W.	...	161	82 H.	Completed to limit of survey.
22 N. W.	...	582	66 S. W.	Completed to margin.
28 S. E.	...	992	12 H.	Electrotyped from full sheet 28;
28 S. W.	...	936	...	border, outside figures and corrections completed.
50 S. E.	...	211	113 H.	Completed to margin.
60 N. W.	...	585	63 H.	
Total	...	3,467	270 H. 66 S. W.	
Quarter sheets (new), in progress.				
11 S. E.	...	670	20 H, 158, S.W.	Outline and writing completed; hills in progress, almost completed.
14 N. E.	...	281	...	Outline and writing completed as far as material supplied.
14 S. E.	...	...	52 H.	Hills in progress.
14 S. W.	1	3,043	...	Outline and writing completed
21 N. W.	70	3,699	...	as far as material supplied.
21 S. E.	108	9,051	6 S.	
21 S. W.	72	4,102	61 S.W. 4 S.	Outline, writing and salt waste completed to margin, awaiting hill drawing.
22 N. E.	15	298	54 H.	Outline, writing and hills completed as far as material supplied.
23 N. E.	...	10	...	Slight additions completed.
24 N. E.	12	5,254	6 S.	Outline and writing completed
31 N. E.	14	3,345	...	as far as material supplied.
35 S. W.	...	64	...	Slight additions to writing completed.
36 N. W.	60	6,374	4 S.	Outline and writing completed
36 S. W.	104	8,045	3 H.	as far as material supplied.
37 N. W.	14	1,530	...	
37 S. W.	28	1,682	4 S.	
38 N. W.	...	150	1 H.	Slight additional writing completed.
39 N. E.	...	3,832	...	Outline and writing completed to margin, awaiting hill drawing.
40 N. W.	151	1,820	...	Outline completed to margin; writing in progress.
42 S. E.	...	559	82 H.	Outline and writing completed to limit of survey; hills completed as far as material supplied; awaiting further hill drawing.
43 N. E.	...	...	56 H.	Hills well advanced; in progress.
47 N. W.	27	2,485	...	Outline and writing completed as far as material supplied.
47 S. W.	17	...	...	Outline completed as far as material supplied.
48 N. E.	...	3,651	40 H.	Outline, writing and hills completed as far as material supplied.
48 N. W.	116	...	...	Outline completed as far as material supplied; writing about to be gone on with.
48 S. W.	41	45	...	Additional outline and writing completed.
49 S. W.	...	455	22 S.	Slight additions completed.
50 N. W.	5	350	...	Outline and writing completed to margin, lakes shaded, awaiting hill drawing.
57 N. W.	...	...	24 H.	Hills just commenced; in progress.
Carried forward	855	60,795	332H. 46S. 219 S.W.	

ENGRAVING OFFICE, CALCUTTA.

Statement of Work—continued.

Title of Map.	Outline. Square inches.	Number of letters cut.	Hills (H.), Sand (S.), Salt waste (S.W.) Square inches.	Remarks.
Indian Atlas.				
Scale 1 inch = 4 miles.				
Quarter sheets (new), in progress—contd.				
Brought forward .	855	60,795	332 H. 46 S. 219 S.W.	
59 N. W.	3	105	...	Additional outline and writing cut.
59 S. E.	50	1,909	...	Additional outline and writing completed as far as material supplied.
59 S. W.	...	...	...	Lakes shaded, awaiting hill drawing.
60 N. E.	...	18	10 H.	Hills just commenced; in progress.
60 S. W.	...	909	...	Additional writing cut and lakes shaded.
61 N. W.	...	1,460	...	Outline and writing completed as far as material supplied.
68 N. E.	163	12,971	...	Outline completed as far as material supplied; writing in progress.
68 N. W.	116	500	...	Old work cleaned out, and supplemented by better outline completed as far as material supplied, writing about to be gone on with.
75 S. E.	...	2,430	...	Lakes shaded, outline and writing completed as far as material supplied.
78 N. E.	3	1,014	...	Corrections to outline and writing completed, awaiting hill drawing.
78 N. W.	4	230	...	Outline and writing completed as far as material supplied.
78 S. W.	...	3,297	...	
79 S. W.	...	...	2 H.	Hills just commenced; in progress on the duplicate plate.
88 S. E.	...	4,273	...	Outline and writing completed as far as material supplied.
102 N. W.	2	1,366	...	Projected borders and outside figures cut; outline and writing completed as far as material supplied.
102 S. W.	3	1,221	...	
103 N. W.	...	11,214	...	Outline and writing completed as far as material supplied.
103 S. W.	27	7,807	...	
104 S. W.	20	1,250	...	Projected border and outside figures cut; outline and writing completed as far as material supplied.
114 N. W.	231	...	...	Outline completed to margin, writing about to be gone on with.
125 S. E.	...	999	33 H.	Slight corrections to writing completed; hills in progress.
131 N. E.	...	254	...	Foot-note cut.
Total .	1,477	1,14,022	377 H. 46 S. 219 S. W.	
Additions and corrections to published Quarter Sheets.				
1a S. E.	...	254	...	Slight additions and corrections completed.
2 N. E.	...	292	...	
2 S. E.	...	312	...	
3 N. E.	...	254	...	
3 N. W.	...	292	...	
3 S. E.	17	545	...	Additional outline and writing completed.
Carried forward .	17	1,949	...	

ENGRAVING OFFICE, CALCUTTA.

Statement of Work—continued.

Title of Map.	Outline. Square inches.	Number of letters cut.	Hills (H.) and Sand (S.). Square inches.	Remarks.
Indian Atlas.				
Scale 1 inch = 4 miles.				
Additions and corrections to published Quarter Sheets.—contd.				
Brought forward	17	1,949	...	
9 N. E.	...	254	...	
9 N. W.	...	254	...	
9 S. E.	...	254	...	Slight additions and corrections completed.
10 N. E.	...	254	...	
10 N. W.	...	254	...	
10 S. E.	...	254	...	
12 S. E.	...	254	...	
16 N. W.	7	800	...	Slight additions to outline and writing completed.
16 S. W.	6	231	...	
22 S. E.	...	10	...	Slight corrections completed.
22 S. W.	...	3,108	2H.	Corrections to district and sub-divisional names completed.
36 N. E.	...	268	...	Slight additions and corrections completed.
36 S. E.	...	65	...	
38 S. W.	...	26	3H.	Corrections and additions to heights completed.
39 S. E.	...	20	...	Slight corrections completed.
39 S. W.	...	20	...	
40 N. E.	...	20	...	
44A N. W.	...	254	...	Slight additions and corrections completed.
45 N. E.	...	254	...	
48 S. E.	8	1,814	...	Corrections to district and sub-divisional names completed.
49 S. E.	...	10	...	Slight corrections completed.
51 N. W.	...	254	...	
52 N. W.	...	254	...	
52 S. E.	...	244	...	
53 N. E.	...	328	...	
64 N. W.	...	292	...	
70 S. W.	...	28	...	Slight additions and corrections completed.
72 N. W.	...	254	...	
92 S. E.	...	254	...	
105 N. E.	...	254	...	
124 N. E.	...	254	...	
124 N. W.	...	254	...	
124 S. E.	...	254	...	
125 N. E.	...	254	...	
125 N. W.	...	292	...	
127 N. W.	...	254	...	
128 N. E.	...	262	...	Slight additions and corrections completed.
129 N. E.	...	254	...	
129 N. W.	...	254	...	
130 N. W.	...	254	...	
130 S. E.	...	254	...	
Total	38	15,629	5 H.	
Additions and corrections to published Full Sheets.				
29	...	1,650	...	Additions and corrections completed.
38	...	122	...	
40	...	...	2 H.	
41	20	3,170	...	Heavy additions and corrections to Railways and names completed.
44	...	92	...	Slight corrections completed.
47	...	...	28 H.	Hills repaired, completed.
49	...	...	2 H.	Slight corrections completed.
54	...	1,511	11 H.	Heavy corrections and additions to district and sub-divisional names completed.
55	...	2,257	...	
Carried forward	20	8,802	43 H.	

ENGRAVING OFFICE, CALCUTTA.

Statement of Work—continued.

Title of Map.	Outline. Square inches.	Number of letters cut.	Hills (H. and Sand (S.). Square inches.	Remarks.
Indian Atlas.				
Scale 1 inch = 4 miles.				
Additions and corrections to published Full Sheets—contd.				
Brought forward .	20	8,802	43 H.	
56	...	152	...	Corrections and additions completed.
62	...	...	193 H.	Hills being repaired; in progress.
63	...	...	83 H.	Hills repaired; completed.
65	5	...	...	
73	...	188	...	Slight corrections complete.
74	...	72	...	
103	...	20	...	
104	...	2,612	20 H.	Heavy additions and corrections to boundaries, roads and district names completed.
Total ...	25	11,846	339 H.	
New plates projected, &c.				
4a. N. E. . . .	...	...	...	Border projected.
4 S. W.	...	...	...	
7 S. E.	...	...	...	
17 N. W.	...	...	...	Borders cut.
17 S. E.	...	...	...	
21 N. E.	...	...	...	
24 S. E.	...	254	...	Portion of outside figures cut.
25 S. E.	...	135	...	Border and portion of outside figures cut.
26 N. E.	...	120	...	Portion of outside figures cut.
26 S. E.	...	99	...	Ditto ditto.
30 N. E.	...	...	...	Border cut.
40 S. W.	...	998	...	Outside figures cut.
57 N. E.	...	190	...	Border completed and portion of outside figures cut.
63 N. E.	...	...	...	
63 N. W.	...	...	...	Reprojected, borders being cut; in progress.
63 S. E.	...	...	...	
63 S. W.	...	...	...	
75 N. E.	...	979	...	Borders completed and outside figures cut.
75 N. W.	...	1,283	...	
87 S. E.	...	68	...	Projected and border cut.
89 N. E.	...	...	...	Projected.
89 S. E.	...	64	...	
104 N. E.	...	...	...	
104 N. W.	...	74	...	Projected, border and outside figures in progress.
104 S. E.	...	...	...	
Total .	...	4,264	...	

ENGRAVING OFFICE, CALCUTTA.

Statement of Work—continued.

Title of Map.	Number of sheets.	Outline. Square inches.	Number of letters cut.	Hill s(H.)and Sand (S.). Square inches.	Remarks.
General Maps.					
India (1 inch=32 miles)	6	...	...	...	.....
Sheet 5 Original	...	...	50	...	Slight additions completed.
„ 1 Outline	...	...	9,912	...	Writing recut where obliterated through the removal of the hills.
„ 4 Do.	...	...	3,535	...	
„ 5 Do.	....	...	809	...	
India (1 inch=64 miles)	4	...	...	...	.....
Sheet 2 Original	...	10	429	...	Additions and corrections to Railways and names completed.
„ 1 Matrix	...	...	...	...	Heavy erasures to names for correction to spelling on the Duplicate.
„ 1 Duplicate	...	10	...	...	Outline recut where obliterated through removal of names; writing about to be gone on with.
India (1 inch=80 miles)	2	...	4,090	...	Corrections and additions to Railways and names completed.
India (1 inch=96 miles)	1	20	350	...	Additions to outline and writing in progress.
India (1 inch=256 miles) (new)	1	54	1,341	...	First stage of outline and outside figures cut ready for the first duplicate to be made.
Andaman Islands (1 inch=4 miles)	2	...	2,624	...	Title, foot-notes, degree figures, &c., cut, plates produced in heliogravure.
Provincial Maps.					
Scale (1 inch=16 miles.)					
Assam	1	...	810	8H.	Additions and corrections completed.
Mysore	1	...	100	...	Plate stopped for corrections to boundaries awaiting corrected drawing.
N.-W. Provinces and Oudh	2	96	22,856	...	Outline completed as far as material supplied, writing well advanced, in progress.
Gujarat	1	110	672	...	Outline corrected, outside figures cut, writing in progress.
Punjab	4	...	23,128	...	One sheet completed in outline and writing well advanced on two other sheets, leaving only one to be put in hand for writing.
District Maps for Administration Reports.					
Backergunge	...	68	992	...	Outline completed, writing in progress.
Balasore	...	28	...	...	Outline completed, writing about to be gone on with.
Bankoora	...	48	1,883	3S.	Completed in outline and writing.
Beerbhoom	...	40	2,047	...	
Bogra	...	26	...	...	Outline completed.
Chittagong	...	55	2,734	...	Completed.
Chittagong Hill Tracts	...	85	1,978	3H.	Outline and writing completed; hills in progress.
Chumparun	...	40	929	6S.	Completed.
Cooch Behar	...	27	1,667	...	Almost completed.
Dacca	...	45	...	...	Outline completed.
Carried forward	25	762	82,936	11 H. 9 S.	

ENGRAVING OFFICE, CALCUTTA.

Statement of Work—continued.

Title of Map.	Number of sheets.	Outline, Square inches.	Number of letters cut.	Hills (H.) and Sand (S.). Square inches.	Remarks.
District Maps—contd.					
Brought forward	25	762	82,936	11 H. 9 S.	
Darjeeling	...	21	1,059	12H.	Outline, writing, and hills well advanced in progress.
Durbhungah	...	30	...	...	Outline completed.
Furreedpore	...	46	1,721	...	Completed.
Hazaribagh	...	10	...	...	Outline all drawn in, portion only cut, plate stopped for examination.
Hooghly	...	21	1,417	...	Almost completed.
Howrah	...	10	...	...	Outline completed.
Jalpaiguri	...	53	...	...	Do. do.
Khulna	...	80	...	...	Do. do.
Lohardugga	...	75	1,610	...	Completed.
Maldah	...	28	...	...	Outline in progress.
Midnapore	...	76	1,971	...	Almost completed.
Moorshedabad	...	35	1,742	...	Do. do.
Nuddea	...	8	...	...	Outline in progress.
Patna	...	33	810	3S.	Completed.
Pubna	...	20	...	...	Outline in progress.
Purneah	...	98	2,728	...	Completed.
Rajshahi	...	27	459	...	Outline completed, writing just commenced.
Rungpore	...	62	3,278	...	Completed.
Sarun	...	42	1,559	...	
Sonthal Pergunnahs	...	45	...	...	Outline completed, writing about to be put in hand.
Sundarbans	...	47	...	...	
Tipperah	...	30	...	...	Outline completed.
Provincial Maps for Administration Reports.					
Assam	...	65	...	...	Projected border and outline cut.
N.-W. Provinces and Oudh	...	...	2,271	...	Almost completed in outline and writing.
Punjab	...	114	524	...	Completed in outline, the first stage, electrotype taken.
Index Maps.					
Index to the Standard sheets of the Central India Agency.	...	...	2,630	...	Projected, writing in progress.
Index to the Standard sheets of the Central Provinces.	...	...	432	...	
Index to the Standard sheets of the Punjab.	...	...	1,575	...	Projected, outside figures cut outline about to be gone on with.
Index to the Standard sheets of the Rajputana Agency	...	76	408	...	Projected, outline cut, writing in progress.
Index to the Indian Atlas	...	...	3,930	...	Almost completed.
Index Chart to the Great Trigonometrical Survey.	...	2	34	...	Slight additions to outline, and writing completed.
Charts.					
Weather chart of India	...	...	...	...	Sea shaded.
Miscellaneous Plates.					
Acre comb scales— 2 inches = 1 mile, 4 inches = 1 mile, 8 inches = 1 mile, and 20 inches = 1 mile.	...	...	1,068	...	Four scales on two plates completed.
Brass designation plates for the Survey of India Offices.	...	...	10,200	...	Three large brass plates completed.
Heading and foot-notes for the sheets of the Calcutta Survey.	...	...	1,481	...	Completed.
Carried forward	25	1,916	125,843	23 H. 12 S.	

ENGRAVING OFFICE, CALCUTTA.

Statement of Work—concluded.

Title of Map.	Number of sheets.	Outline. Square inches.	Number of letters cut.	Hills (H.) and Sand (S.). Square inches.	Remarks.
Miscellaneous Plates—contd.					
Brought forward .	25	1,916	1,25,843	23H. 12S.	
Heliogravure plates . . .	...	...	5,738	...	Titles, scale, and sectional shading cut, to eleven plates for the Photographic Office.
Specimen of writing for district maps.	...	...	500	...	Completed.
Maps heading	...	...	400	...	Additional writing cut.
Two and a half inch squares .	...	...	298	...	A double elephant plate with two diagonal scales completed.
Viceroy's appointment plate .	...	...	1,374	...	Lord Lansdowne's crest and writing completed.
Other small plates	...	...	500	...	Miscellaneous writing cut.
Total .	25	1,916	1,34,653	23H. 12S.	

Abstract of Work.

	Plates.
Engraving.	
Atlas sheets completed	6
Ditto in progress	48
Ditto repairs, corrections, and additions to published plates . .	64
Ditto projections engraved, borders cut, &c.	25
General maps	83
Total .	226
Copper plate-printing.	
Impressions taken	18,743
Proofs pulled	539
Transfers printed	311
Total .	19,593

	Plates.
Steel-Facing.	
Double elephant plates steel-faced . .	40
Ditto ditto steel-removed .	11
Quarter sheets ditto steel-faced .	33
Ditto ditto steel-removed .	19
Miscellaneous ditto steel-faced .	71
Ditto ditto steel-removed .	13
Total .	187
Square inches of hill etching and sand waste	1,357
Square inches outline	3,456
Number of letters engrave . . .	2,83,881

PHOTOGRAPHIC AND LITHOGRAPHIC OFFICE, CALCUTTA.

Extract from the Narrative Report of COLONEL J. WATERHOUSE, S.C., *Assistant Surveyor-General—season 1888-89.*

Hitherto the work executed in the Photographic and Lithographic Offices has been reported on separately, but as both offices have been now brought under one roof in the new building, it has been thought desirable to have only one report and one set of statements. During the current year it is proposed to formally amalgamate the two offices under the title, already in use, of the "Photographic and Lithographic Office." For convenience the old denominations will be used in the present report, because the work has been done by two distinct establishments.

OUT-TURN.—During the year under review there has been a steady increase of out-turn in nearly every section, and for the greater portion of it the offices have been working under considerable pressure to meet the ever-increasing demands made upon them. The increase of work has come almost entirely from other departments, the ordinary departmental work done in the Photographic Office (not including cadastral work, which has again fallen off) being slightly in excess of last year, while that done in the Lithographic Office has decreased.

ORIGINAL SUBJECTS.—In the Photographic Office, the total number of subjects received for reproduction amounted to 4,737, of which 799 were ordinary departmental maps, 351 extra-departmental maps, and plans, and 3,587 cadastral maps. Last year the total number was 5,340, the actual number of extra-departmental original subjects, *viz.*, 842, having been considerably higher, though the number of copies reproduced was far less than has been the case this year.

The number of departmental maps, plans and forms lithographed was 160, or 17 less than last year. This work is steadily decreasing, but the decrease is more than made up by a corresponding increase in the number reproduced by photography, indicating a growing tendency to substitute the more expeditious process of photo-zincography for hand-drawing in reproducing departmental maps. Of work done for other departments 643 original subjects were received, or 104 more than last year.

PHOTOGRAPHIC NEGATIVE SECTION.—The total number of negatives taken during the year was 4,796, including 93 reversed negatives. Of these, 1,264 were of departmental and 713 of extra-departmental maps and plans, as against 1,029 and 972 respectively in the preceding year, and 2,819 were of cadastral maps, against 2,971 last year. No necessity has arisen for any modification of the methods of working in use at the beginning of the year. Mr. H. Haward continued to hold charge of the section and has introduced an improved system of working the establishment. The section was moved into the new building just before the close of the year, and it is satisfactory to report that the lighting and arrangements of the new glass-house and the new dark-rooms have been found a great improvement on the old ones, though a proper system of ventilation is still required.

PHOTO-TRANSFER SECTION.—The number of photo-transfer prints prepared was 4,513, of which 994 were of departmental, 698 of extra-departmental maps and plans, and 2,821 of cadastral maps.

In this section also, no change was made in the processes or mode of working, but the introduction of gas into the new buildings has enabled improvements to be effected in the mode of drying the sensitive paper in a more cleanly and better manner than by using charcoal, as hitherto. The latter was dirty and unwholesome. A plentiful supply of hot water at a moment's notice has also been secured by the use of a Ewart's Patent "Lightning" Geyser heated with gas, instead of having to heat the water in a boiler with wood. The accommodation now enjoyed by this section is far more commodious and better lighted than was the case in the old building and the arrangements are all working satisfactorily.

ZINC-PRINTING SECTION (NORMAL).—This section has been under the charge of Mr. E. A. LeFranc the whole year, and there has been a heavy pressure of work throughout.

The number of zinc plates printed was 643 (309 departmental and 334 extra-departmental), the number of pulls being 123,262 (53,397 departmental and 69,865 extra-departmental), and of complete copies 180,648 (49,533 departmental and 131,115 extra-departmental), showing a considerable increase of both departmental and extra-departmental work, though the number of plates printed was smaller than last year. 3,642 plates of cadastral maps were printed, the number of pulls being 103,882 and of copies 96,290 of complete villages. The out-turn under this head is decreasing annually, but the establishment is utilised for meeting the heavy demands for extra-departmental maps. The supervision of this branch of the work has remained under Mr. Watson. As he had expressed a wish to retire on attaining the age of 55 in October, or as soon as Mr. B. Mackenzie, the head zincographer, returned from furlough, arrangements were made to secure the services of Corporal F. R. Vandyke, R.E., of the Queen's Own Sappers and Miners, at Bangalore, with a view of his assisting in the office work and being appointed permanently on Mr. Watson's retirement, if he gave satisfaction. Corporal Vandyke joined the office on the 2nd August 1889, and has done good work, and seems in every way fitted for the post; his acquaintanceship with steam machinery, acquired during an apprenticeship of several years with first-class lithographic printing firms in England, will be found very useful when the new steam machinery is set to work.

LITHOGRAPHIC DRAWING AND PRINTING SECTIONS.—The lithographic drawing section should properly have been considered at an earlier stage of the report, but its work

is so interwoven with the printing section that it is more convenient to treat them together. In the drawing section, 712 new drawings or additions made to maps, &c., on stone were taken up and completed during the year. Of these only 69 were departmental, the remainder being for other departments.

In the printing section, the number of subjects printed was 652, the number of pulls 342,820, and of copies 368,673. Of these, 130 subjects, with 64,328 pulls and 59,928 copies, were departmental, and 522 subjects, with 278,492 pulls and 308,745 copies, for other departments.

The work done for other departments in this branch of the office is yearly increasing, and at one time during the year the demands upon the lithographic draftsmen taxed their powers to the utmost. If extra-departmental requisitions continue to increase, as it seems probable they will, it will be necessary to strengthen the drawing staff. Mr. H. L. Lepage, head assistant, has supervised the whole of the lithographic work, including the type-printing, throughout the year, and Mr. D. Deas, head litho-printer, has continued in charge of the litho-printing presses.

TYPE-PRINTING SECTION.—In this section also the work has again considerably increased; the number of pages or items set up was 6,646, and the number of pulls was 1,177,175, yielding 534,257 finished copies. Last year the number of pulls was 986,666, from 5,375 items and the number of finished copies 497,289. Mr. DePyvah, head type-printer, has continued to hold charge of the section.

In the new building the whole of the lithographic drawing and printing sections, the type-printing section and the zinc-printing sections (normal and cadastral) have been brought practically together in one large hall, the lithographic and type sections occupying the ground floor, while the lighter zinc-printing presses and the zinc correctors are in the galleries above. The arrangement is found to work well, and has the advantage that the whole working power of presses and draftsmen can be most effectively utilised; the supervision is more perfect, and in other ways also the convenience of all the printing and drawing staff being together is very great.

SILVER-PRINTING SECTION.—The amount of silver-printing done during the year has been much less than usual, only 389 prints having been made. There have been very few demands for work of this kind from outside departments, and for departmental work the cyanotype or blue print process answers all ordinary purposes and is cheaper and simpler. 1,096 cyanotype prints have been supplied, chiefly of reductions of standard sheets, for use in the Drawing and Engraving Offices. The accommodation of this section has been very greatly improved in the new building and three rooms suitably lighted with yellow ground-glass windows, and fitted with sinks and water-supply, &c., have been allotted for the exposing, sensitising and washing of prints.

PHOTO-COLLOTYPE PRINTING SECTION.—Only four plates were prepared in this section from two subjects and 826 copies printed. As stated in last year's report, the photo-collotype process has been almost entirely superseded by heliogravure, though it will still be very useful as a means of supplementing our powers of reproducing high-class subjects, especially when there is an extra pressure of work in the heliogravure section. Improved accommodation has also been allotted to this section in the new building, a large, well-lighted room for the presses, and a smaller dark-room for preparing plates.

HELIOGRAVURE SECTION.—This section has been well employed throughout the year. Fifty plates have been prepared by the photo-etching process by Mr. Turner, from which the very large number of 20,307 copies have been printed off, or nearly double the number printed last year, not including 7,669 copies printed in the Engraving Office. Since the removal of the office into the new building, three copper-plate presses have been kept at work under Mr. Turner's immediate supervision, though when there is a press of work plates are sometimes printed in the presses attached to the Engraving Office.

Electrotyping of the hand-engraved copper-plates has been carried on during the year, as required by the Engraving Office, and affords a valuable and economical means of duplicating plates or of obtaining engraved plates of standard general maps in various stages of progress. Twelve plates were electrotyped, or one less than last year, and facsimiles were made of an important silver-copper seal of Kumara Gupta II, for the Asiatic Society and Indian Museum.

Photo-etching Process.—This process has been employed for all classes of subjects, and has been found equally useful in reproducing pictures from nature and drawings in line. In all material points it has been worked precisely as described in last year's Report. The method of lettering the transparencies by printing from type on thin slips of collodionised gelatine, therein referred to, was frequently employed and found very useful, as also was the method of introducing flat or shaded tints, which was found to add very much to the utility of the process, particularly in improving an uneven back-ground. By its means irregularities arising from a defective negative or due to the material used as a back-ground can be evened up in a remarkable way. A tint laid on the face of an etched plate seems to lighten the shadows and darken the lights, thus producing an even ground, instead of a rough and irregular one.

During the past year a method of transferring and joining up several transparencies to form one plate has been devised by Mr. Turner and found very useful. By its means we are now able to undertake subjects hitherto impossible, as it enables several different subjects to be etched on one plate and printed together, thus saving a great deal of time and labour in printing.

The method adopted is as follows:—A clean glass plate is polished with French

chalk, collodionised and washed. Transparencies of the different subjects required to be etched together on one plate are developed on it in the usual way, and when dry a sheet of paper, thickly coated with gelatine is *squeegeed* upon the glass plate. The paper is allowed to dry, when it will easily come away from the glass support, bringing the image with it. The transparency on paper can now be cut up, and the different subjects joined together in any way required, just as photo- or litho-transfers are treated. The several parts of the transparency are put in position on a second sheet of paper and secured with a little India-rubber solution. The whole is now immersed in cold water and allowed to soak for a minute or two, and then *squeegeed* down on a plain or collodionised plate. After five or ten minutes the plate is placed in a dish of warm water (100° to 110° F.) when the paper support will float off, or, if it does not, it may be carefully stripped from the glass and will leave the transparency in exact position. The method necessarily requires care and delicate manipulation, but it has proved of great practical use.

Considerable difficulty has always been experienced in avoiding reticulation when preparing transparencies with the Autotype Company's special transparency tissue. This is now overcome by collodionising the glass upon which the tissue is *squeegeed* after sensitising; or the tissue, when sensitised, may be coated with collodion. During the rainy season a few drops of carbolic acid in the sensitising bath is found to give additional clearness to the image and prevents the formation of a film of insoluble gelatine which is so liable to occur at this time of the year.

The photo-electrotype process has not been used during the year. It is, however, a valuable process for many purposes and is likely to prove of use for preparing half-tone transfers to stone or zinc. Some further experiments have been made in this direction, which promise well. There has been such a constant stream of current work that there has been but little time for experiment.

The new accommodation in this section also is a very great improvement on the old. The introduction of gas gives the means of heating the copper-plates for printing in a cleanly and effective manner and more uniformly than can be done with fire-balls, and the same with regard to the heating of the heliogravure plates after the dust-grain has been laid on them. With the aid of a geyser, supplies of clean, hot water at any desired temperature can be obtained at a moment's notice, for developing the transparencies and negative prints on the copper. The section occupies five rooms on the ground floor—one being devoted to the copper-plate presses, one to the preparation and development of the heliogravure plates, while the etching is done in an adjoining room, and the engraving and touching up of the plates and the electrotyping are done in two other rooms on the other side of the passage, the former enjoying a fine north light.

The section has remained under supervision of Mr. Turner during the year, and, since the removal of the offices, he has also supervised the working of the Collotype and Silver-printing sections carried on by Mr. J. T. Meade and Mr. C. J. Meade respectively.

NEW BUILDING.—The main feature of the year has been the completion and occupation of the new office buildings, No. 14, Wood Street, in which the Photographic and Lithographic Offices are now located. These two offices have for many years past been situated in three private houses, an arrangement which rendered it very difficult to supervise the work efficiently, while the accommodation also was insufficient and unsuitable, some of the work having to be carried on in small dark out-houses. In the new building adequate accommodation has been provided for all the sections, and there can be no doubt that this will have its due effect on both the quantity and quality of the work performed, as well as on the *morale* and health of the establishment, who will work under far better conditions in every way than they have hitherto done. It has also become possible, now that the two offices, which have hitherto been entirely separate establishments, are brought together under one roof, to amalgamate them; this has in part been effected, and will, it is hoped, be completely carried out during the ensuing year.

It is not too much to say that the new office, now that it is completed, will compare favourably in respect of the accommodation and appliances it contains, its reproducing power, and the variety and style of the work which it is capable of turning out, with any other map-reproducing establishment, private or otherwise, in Europe. It may not, therefore, be out of place to give here a brief description of the general arrangement of the interior and of the improvements which have been carried out in each section.

The building is situated between the Surveyor-General's Office and the new Mathematical Instrument Office, and is laid out in the form of a square with a quadrangle in the centre, the front entrance and face being in Wood Street.

As will be seen from the view given in the frontispiece to this report, the arrangement generally is two-storied with turrets at the ends of the front face and on both sides of the gateway. The rooms on the north side of the entrance are devoted to the lithographic and zinc-printing sections, while those to the south accommodate the stores and various photographic printing sections and the electro-typing, on the ground floor, and on the first floor the administrative offices and the glass-houses, with dark-rooms attached, belonging to the negative section.

Water is laid on throughout; a constant and abundant supply being secured by six 400-gallon tanks on the roof, which can be filled if required by means of a steam force-pump, and most of the photographic rooms, in which cool water is a necessity, have each a separate cistern, which also forms a reserve in case of the supply running short.

Gas has been laid on to the heliogravure and photo-transfer printing rooms as well

as to the officers' laboratory and dark-rooms, and is a great convenience for drying and heating purposes. The want of it was much felt in the old quarters, where large charcoal fires had to be kept up in small and confined rooms.

The floors all through the building have been made of Garlick's patent stone in slabs, or, in the case of the large press room and its galleries, laid down in a sheet. This flooring seems hard and durable, can easily be washed, and entirely obviates the necessity for matting in any of the rooms, thus preventing any accumulation of dust and vermin.

As far as possible, perforated zinc ventilators have been placed above the windows of all the rooms, so as to secure a supply of fresh air during the time when the rooms are shut up. In the morning a great difference is found in the freshness and coolness of the rooms so ventilated and of those not so.

The photographic dark-rooms have all been fitted with double windows, one being glazed with yellow ground-glass and the other with plain white glass, so that either white or yellow light can be used at pleasure. All the photographic rooms are provided with suitable sinks and fittings which enable the work to be performed under much better conditions than was possible with the makeshift arrangements under which we have struggled along for the last twenty years.

The general appearance of the interior of the quadrangle and of the glass-house and press-room is shown in the accompanying plates, and the extent and distribution of the accommodation in the two plans, on which the rooms have been numbered for easy reference.

Many of the special arrangements have been described when treating of the different sections, but it may be well to give a short description of the building in detail following the numbering on the plans.

Entering at the principal gate, the time-keeper's lodge, No. 1, is seen on the right: here the attendance is checked. Above it is a small room used as a store-room for spare apparatus in the heliogravure section. Further on, to the right, room No. 2 is entered. This is devoted to the collotype printing, and contains three presses for that purpose, two Albion and one of Poirrier's, besides a ruling-machine for stones or copper-plates. The room is also used for cleaning and polishing copper-plates for the heliogravure process. It is well lighted with grey glass windows and ventilated, and gas and water are laid on.

In No. 3 are three copper-plate presses for printing the heliogravure plates. Gas is laid on to the heaters for inking in, and water-supply for wetting paper, &c. No. 4 is glazed with yellow glass in addition to the usual windows, and is devoted to the sensitising and drying of the sensitive tissue used in the heliogravure process and also for developing the pigment prints for transparencies and transferring on copper. For this purpose, there are ample supplies of cold water to two sinks, and a 'lightning' geyser heated with gas enables warm water to be obtained whenever required. The dusting box for giving the grain is also in this room, and a heater similar to those in the printing room, also lit with gas, is useful for fixing the dust-grain and other purposes. No. 5 is a small but well-lit room, in which the heliogravure plates are etched. No. 6 contains accommodation for two engravers employed in lettering and touching up the heliogravure plates. It also serves as an office room for Mr. Turner, and for keeping chemicals, plates, &c.

No. 7 is used for preparing collotype plates. It is glazed with yellow glass, and contains a drying box which is usually heated with a petroleum stove, though gas is also laid on. In No. 8, the tray-batteries for electrotyping are arranged on a central and side tables. There is a weighing-machine for weighing the plates, and ample water-supply.

Rooms Nos. 9, 10 and 12 are devoted to the silver and cyanotype printing. Nos. 9 and 10 are yellow-glazed and serve for the sensitising, exposing and toning of silver-prints or for sensitising and exposing cyanotype prints, while No. 12 is fitted with apparatus and sinks for the final washing of prints. The first washing of silver-prints is conducted in No. 10, and all washing waters containing chloride are carried into a cistern outside and left to precipitate, and in like manner the fixing baths of hyposulphite of soda are carried after use into an adjoining cistern and precipitated with scrap zinc.

No. 11 is used as a store for negatives that have to be kept and for the stock of used glass available for negatives. In the verandah outside, old negatives are cleaned off after steeping in troughs of water. The glass-cleaners sit at low sloping tables covered with felt and supplied with water, each table being surrounded by a low masonry wall which prevents water slopping over and keeps a dry passage-way.

Inside the well of the staircase adjoining this room there is a hand-lift for taking up and down glass plates and negatives.

Turning now to the east wing, rooms Nos. 13, 14, 15 and 16 are assigned to the photo-transfer printing, and are all glazed with extra yellow glass windows. Gas is laid on in room No. 16 to the drying box in which the bichromated gelatine paper is dried, and also to a geyser which supplies the washing troughs in No. 14 with hot water when required. The paper is coated in No. 15, and there is also a lithographic press for coating the prints with transfer ink. In No. 13 the sensitive paper is filled into the frames before exposure and removed afterwards. It also serves for joining up the finished photo-transfer prints and as an office for the assistants.

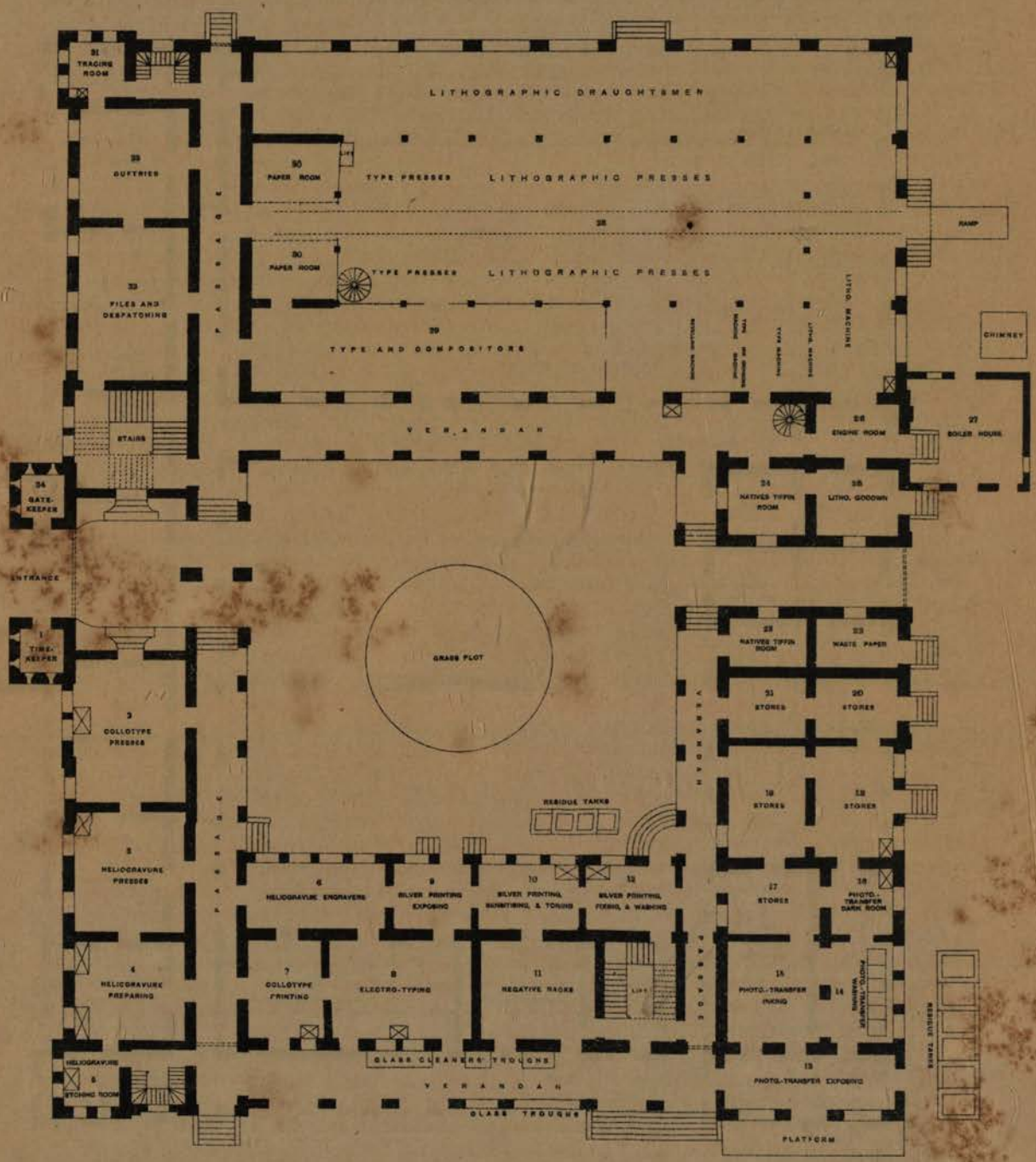
Nos. 17, 18, 19, 20, and 21 are store rooms, and are fitted with shelves as required. No. 18 is the Store-keeper's office, and has water laid on for mixing chemicals and other purposes. Outside the room is a shallow sink with water-supply for washing bottles, &c. These rooms have all been purposely made small in order to give good support to the floor of the glass house above. No. 22 is a store for waste paper, and No. 23 is a press store

PLAN OF

NEW PHOTOGRAPHIC & LITHOGRAPHIC OFFICE,

SURVEY OF INDIA DEPARTMENT, CALCUTTA.

GROUND FLOOR.



Reg. No. 2742, S. I. D.—4-1-90—500.

PLAN OF

NEW PHOTOGRAPHIC & LITHOGRAPHIC OFFICE,

SURVEY OF INDIA DEPARTMENT, CALCUTTA.

FIRST FLOOR.

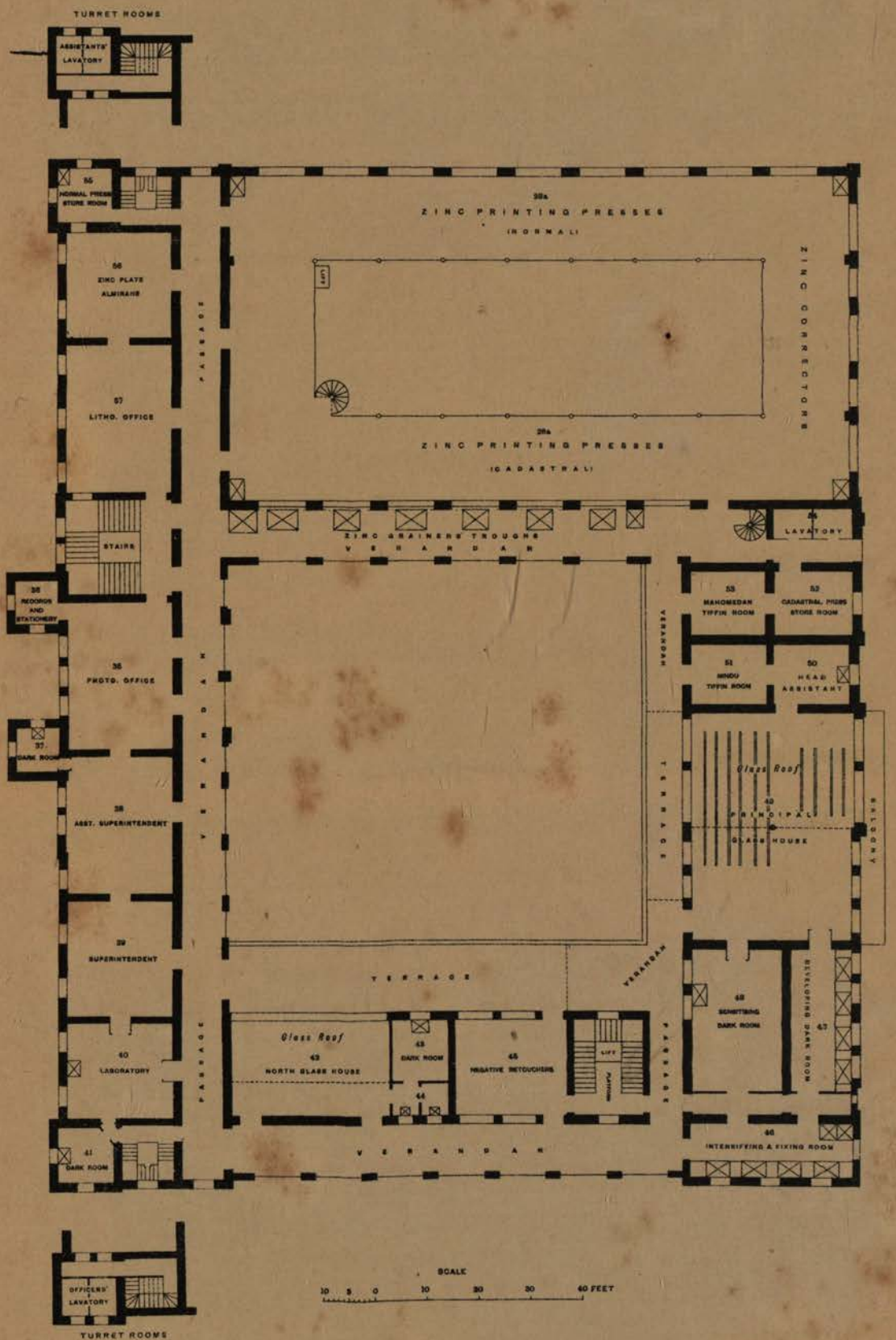


Photo-litho., S. I. O., Calcutta.

THE LITHOGRAPHIC & ZINCOGRAPHIC PRESS ROOM.

Photo-etching. Survey of India Offices, Calcutta, March 1890.

SOUTH WEST CORNER OF THE QUADRANGLE, WITH NORTH GLASS HOUSE.

room which can also be used as a luncheon room for native assistants. Nos. 24 and 25, on the other side of the archway, are similarly used.

No. 26 is the engine-room and contains a Willan's patent two-crank compound central-valve engine, D size, to drive the machinery in the adjoining press-room. Attached to the engine-room is a boiler-house, No. 27, containing a 12 horse-power locomotive boiler by Messrs. Marshall & Co., of Gainsborough, also a steam pump for supplying the office with water. It is further proposed to have a still for distilling water in this room.

Outside the boiler-house, and not shown in the plan, is a store-room for keeping lithographic stones. It is in three sections, each 8 feet by 60 feet, some of the sections being fitted with shelves to take small stones. The accommodation is calculated for about 900 stones of various sizes. The stones required to be kept are placed inside, while the clean stones and those available for cleaning are stacked along the outside wall. In the old office the stones were scattered in out-houses, verandahs and pent-roofs, exposed to the weather, and many stones were damaged. Now all can be kept together under cover and much more conveniently.

Returning to the main building, we ascend by a ramp to the large printing hall, No. 28 (see plate I), which occupies nearly the whole of the north side, and accommodates all the zinc-printing and lithographic presses and the type presses, besides the draftsmen and zinc and stone correctors and clerks attached to the zinc and litho-printing sections. It is 120 feet long, 62 feet wide and 35 feet high, and has a gallery 16 feet wide supported by iron pillars running round it. This gallery is occupied by the whole of the zinc-printing establishment, the lithographic and type-printing sections and the machinery being located on the ground floor below. The floors throughout are laid in patent stone, except along the centre of the ground floor, where a wooden pavement, 6 feet wide, has been laid down for the trollies used in carrying the lithographic stones to and fro to run upon. A narrower strip of the same pavement runs along the floor of the part to the north occupied by the lithographic draftsmen. On the south side of the room a space has been set apart for the compositors and type-racks, and in order to guard against theft of type it is fenced off with a screen of wire netting which well admits air and light. The west end of the room has been fenced off in a similar way for keeping supplies of printing paper.

The lithographic draftsmen on stone and paper are ranged in two rows of separate tables under the gallery on the north side, and have a very fine diffused light coming from the large windows all along, which are glazed with ground glass. The steam machinery is placed under the south gallery in the part not occupied by the type section. It consists of:—

(1) A special quad-crown litho-machine, by Messrs. Furnival & Co., which is adapted also for printing from zinc plates.

(2) The small hand-power litho-machine, which has been in use for some years in the lithographic printing section and will now be worked by steam.

(3) The Bremner type-printing machine, which has also been in use some years and is now working in the Mathematical Instrument Office.

(4) A Caxton demy-folio printing machine for steam or treadle, by Messrs. Furnival & Co.

(5) An ink-grinding machine.

(6) A milling machine by Messrs. Muir & Co. for bevelling zinc and copper plates and for separating electrotyped plates and trimming their edges.

It was intended to have had an overhead travelling crane for lifting the stones on the presses, but as it was found that no advantage was likely to accrue from its use, it was not put up.

The zinc-printing presses take up the two sides of the gallery; those employed on office work being placed in the south side and the cadastral presses on the north, while zinc-correctors occupy the east end and the clerks the west. The large windows to the north and east are glazed with ground glass, protected from hail by wire netting outside. The zinc-grainers work in the verandah on the south side of the room, at six troughs furnished with water-supply and waste-pipes.

About 230 men are employed in this large press-room, and it may be imagined that during office hours, when all the presses are working, it presents a very animated spectacle.

Of the remaining rooms on the ground floor, No. 31 is used as a tracing room by the lithographic draftsmen; No. 32, by the duftries for cutting paper, preparing tracing and transfer paper, and other such work, and No. 33 is occupied by the racks containing file copies of printed maps and by the clerks in charge of the paper stores and map despatching. No 34 is the gate-keeper's lodge, and above it is a small *entresol* room occupied by the head peon.

Ascending the main staircase to the right, No. 35 is occupied by the clerks and office of the photographic establishment, and a small room (No. 36) in the turret contains racks for keeping records, while the similar room, No. 37, attached to No. 38 which is occupied by the Assistant to the Superintendent, is fitted up as a dark-room for experimental purposes.

No. 39 is the Superintendent's room, beyond which and separated from it and from the passage by double doors is No. 40, which has been suitably fitted up as a laboratory for experimental purposes. It is glazed with yellow glass, and gas and water are laid on.

Communicating with this room, again through double doors, is a small room, No. 41, fitted up as a dark-room for development of negatives, &c. From the other side of this room a stair leads to the officers' lavatories in a turret room.

In the south wing, contiguous to the Superintendent's room, a convenient glass-house about 30 feet by 18 feet has been erected for photographing subjects other than maps and plans drawn in pen and ink, which come in for reproduction and require special lighting and treatment. It is lighted from the north, just in the same way as an ordinary photographic studio. The roof slopes towards the north, the head of the slope being 16 feet 6 inches, and the lower end of it 11 feet 6 inches from the ground; the horizontal width of the glazed roof is 11 feet 6 inches. The height of the north side is 11 feet 6 inches, of which 9 feet 6 inches are glazed with ground glass in the same way as the roof. This gives a very soft diffused light, which can be shaded off as required by curtains. A good-sized dark-room, No. 44, is attached, also a smaller one, No. 44, the communication to the two from the glass-house being by an antechamber forming a double door and fitted with a sink for washing plates, &c. The next room, No. 45, is occupied by the men who touch up negatives, and it is lit with large windows towards the north. Immediately adjacent to this is the staircase with hoist for carrying negatives and glass plates up and down between the ground and first floor. A verandah runs along the south side of this wing, and a terrace along the north side.

The east wing of the first floor is taken up almost entirely by the glass-house and other rooms occupied by the negative section. The principal glass-house, No. 49, accommodating five cameras, is placed in the centre of the east wing, with the plan-boards facing the south as in the old glass-house, but in all respects it is a great improvement over the old house and seems to answer the purpose admirably. It is in the first place very much longer; the area of the glass roof is about double the old one, so that more light is available, and, owing to the ridge roof, falls on the plans at a much lower angle. It also has a much clearer light to the east and west than the old one. The framework is of iron as light as it could be made. The whole of the glazing is of ground glass, and there is always a very fine, even, diffused light, without shadows, on the plan-boards. The space behind the cameras has been extended to give more room for storing and laying out maps. Free ventilation is secured by doors and by openings in the side sashes.

Being situated on an upper floor, it was not possible to carry out any arrangements for isolating the plan-boards and cameras from the walls, in order to prevent vibration, as in the old glass-house, but care has been taken to strengthen the floor as much as possible by making several small rooms below. The distance of the glass-house from the road is much greater than formerly, and there is apparently less vibration than there was before. It is to be hoped that the working of the machinery in the printing room will not be felt.

The plan-boards formerly in use with the two large cadastral cameras have been retained, but for the other three cameras a new arrangement has been adopted which seems to answer well. Attached to the wall is a large wooden frame which is prevented from warping by being constructed of 2-inch lattice work, the exterior frame-work and the horizontal bars being of teak wood, while the vertical bars are of deal; the latter being softer for the pins used in fastening down plans. If necessary, this lattice-work frame can itself be used as the support for very large maps, &c., to be copied, but for ordinary work three plain deal-wood plan-boards, made to fit together so as to form one plane surface, are bolted down to the lattice-work, so that they can easily be removed when necessary. Plate II shows these arrangements.

The dark-rooms attached to the glass-house are far more commodious than the old ones, and are arranged on a new plan. Formerly the coating, sensitising and development were carried on together in two rooms, one for the cadastral and the other for the normal work. Now the coating and sensitising of all plates are done in one large room, No. 48, while the developing is done in another, No. 47. They are connected with the glass-house by double doors, and the dark frames containing sensitive plates are passed from the sensitising room into the glass-house, and thence into the developing room and back again into the sensitising room through wooden boxes let into the walls. In a third room, No. 46, the negatives are fixed and intensified. The sinks in the developing and fixing rooms are connected with a range of masonry tanks, situated on the ground just below, on the east side of the building, in which the silver residues are collected. This arrangement is entirely new; it consists of two similar series of three tanks connected with each other, but on different levels; one series being devoted to the collection of the washings from the developing room and the other of those from the intensifying room. These washings flow first into the highest of the series, where the bulk of the silver is deposited; the waste water is then run off into the tank next below, where the remainder of the silver is deposited, and then into the third and lowest tank. This tank is half emptied every morning and filled up from the next higher one and that again from the top one. In this way the settlement of the waste silver takes about sixty-four hours.

A small room, No. 50, opening out of the glass-house, has been provided for the head photographer for use as an office and work room, and for the safe custody of chemicals, original maps, &c., and adjacent to this are three other small store-rooms, Nos. 51, 52 and 53, which are also used by the assistants as luncheon rooms. A lavatory for the European assistants has also been provided.

The gallery of the large printing room on the first floor has already been noticed, as

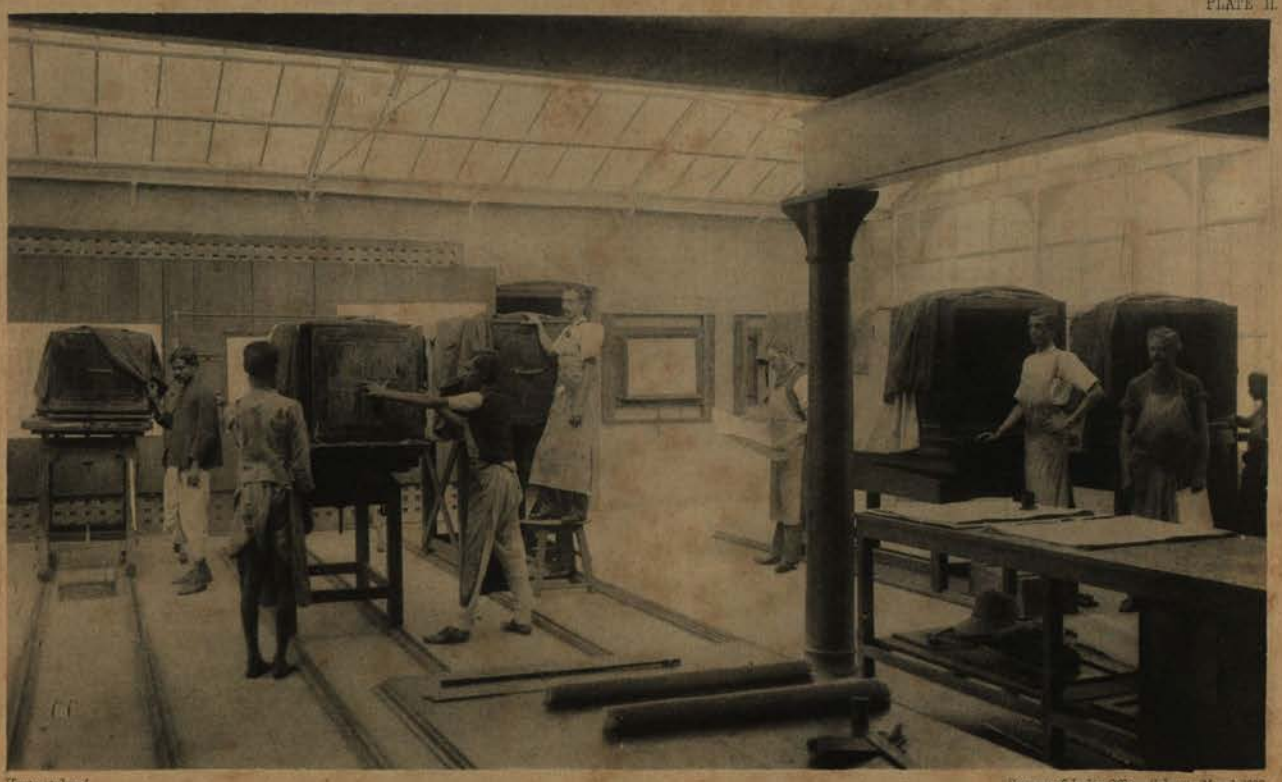


Photo-etching. Survey of India Offices, Calcutta, March 1890.

INTERIOR OF THE SOUTH GLASS HOUSE.

Photo-etching. Survey of India Offices, Calcutta, March 1890.

SOUTH EAST CORNER OF THE QUADRANGLE, WITH SOUTH GLASS HOUSE.

well as the verandah. Passing along the latter we come to the passage on the west side into which the remaining rooms on the first floor open. No. 55, in the turret, is a store-room for zinc-printing stores, &c., and above it is a second lavatory for the European assistants in the printing sections. No. 56 contains the racks for the zinc plates and No. 57 is the office for the lithographic sections.

The out-houses comprise, besides the stone-store already noticed, four servants' houses and a large open shed, part of which is devoted to the carpenters and part to the stone-polishers of the lithographic printing sections.

I have to acknowledge the assistance received from Colonel G. F. S. Neill, the Superintendent of Works, Mr. W. B. Gwyther, the Architect, Mr. Davies and Mr. M. H. Jackson, the Executive Engineers in charge, who have all done their best to carry out my wishes in respect to the special fittings and arrangements necessary for the office. Mr. W. Girling, the Assistant Engineer, who superintended the building and fitting up, was also most obliging and anxious to do all he could to make the building a success.

REMOVAL OF THE OFFICES.—The greater part of the rooms on the photographic side and front face of the building were ready for occupation in May 1889, and as the lease of No. 2, Wood Street, expired on the 15th June, the heliogravure and collotype sections began to move over at the end of May into their own rooms, while the cadastral zinc-printing presses were moved temporarily into some of the lithographic rooms on the ground floor. The removal of these sections was effected very speedily, and with very little expense, as the presses were taken down, moved over, and set up again by the pressmen and coolies employed in working them. As Mr. Ezra had requested us to turn out of No. 1, Camac Street, by the 1st August, every effort was made to get the large press-room ready to receive the Lithographic Office by that date and with success. The roof of the press-room was completed by the 20th July. The lithographic establishment was moved over, and the old premises, which had been occupied by the office for thirty-seven years, were vacated on the 31st July.

The greatest work in connection with the removal of the Lithographic Office was the removal of the stones, numbering about nine hundred. They were first of all classified and re-marked and numbered in accordance with the position assigned to them in the new stone godown. It was then easy to place each stone in its proper position. The removal took nearly the whole of the month of August, but went on regularly, and we found that we were able to do it ourselves very much cheaper than we could have done it by contract.

The removal of the administrative offices, the normal zinc-printing, photo-transfer printing and silver-printing sections from No. 1, Wood Street, was effected gradually during the month of August, and the house was given up on the 31st. As the new glass-house was not ready for occupation at that time, the compound of No. 1, Wood Street, was retained for the month of September at a rental of ₹50. By the 30th September the whole of the offices were working in the new building. The actual cost of the removal was ₹541-5-6 for both offices, but a good deal of additional fitting up was necessary which had not been carried out at the end of the survey year.

EXPERIMENTAL AND PERSONAL WORK.—The work connected with the fitting up of the new offices and the removal into them took up nearly the whole of my time during the year, till I had to go on leave in September owing to ill-health, and consequently there was little time for experimental work. I was, however, able to continue some of my work in photographing the spectrum with a Rowland's grating. I also tried a new fluorescent dye called "Rhodamine," recently introduced by the Badische Anilin and Soda Fabrik, in Stuttgart, which I thought might be useful in orthochromatic photography as a substitute for the eosin dyes. I found that in solution of 1 : 10000 or 1 : 5000 of water with 1 to 1½ per cent. of ammonia, it was almost equal to erythrosin for copying coloured pictures. I also tried it in combination with nitrate of silver, but the precipitate formed on adding nitrate of silver to a solution of the dye is very soluble in water, and it is therefore not easy to prepare plates with rhodamine-silver in the same way as with erythrosin-silver. So far as could be ascertained the addition of nitrate of silver did not increase colour sensitiveness, but further experiment is necessary. I also found that alizarin blue gave gelatine dry plates great sensitiveness to the extreme red rays of the spectrum and with the Rowland's concave grating, using as a screen solutions of tartrazin or bichromate of potash, I was able to obtain very good photographs of the region between B and A with lines in the infra red to about λ 8,300. Experiments were made to see if this extreme sensitiveness to the red rays could be availed of in orthochromatic photography, using the dye alone or with erythrosin. The results obtained, however, with the dye alone or in combination, and used either with a yellow screen or with yellow and red screens in succession, show no very marked increase of sensitiveness to red pigments. Several other dyes, including nile blue, alkannin, alizarin red, and alizarin, have been experimented with, as well as salicin and guaiacum, both of which substances are said to increase the sensitiveness of bromide of silver to the red rays of the spectrum, but with no effective practical result. Further experiments are, however, necessary.'

I was on deputation to Dehra Dun from the 21st October till the 14th November 1888, with the object of examining and reporting on the working of the photographic and zinc-printing sections of that office. I also had charge of the Drawing Office from the 11th April to the 14th August.

I have to acknowledge the great assistance received from Mr. Pope in carrying on the duties of the offices during the year and in drawing up this report.

Statement of Departmental Work done

Specification of Plate or Print.	Sheets or subjects in hand.	Nature of Work.	Scale of Map.		Size.	Negatives and transparencies.	Photo-zincographic and Lithographic Printing.							
			Original.	Reproduced.			Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Stones.	Pulls.	Number of copies.		
												Colored.	Uncolored.	Total.
Atlas Sheets.			In. M.	In. M										
Quarter sheet No. 47 S.E.	2	Litho.	1=4	1=4	¼ Atlas	...	...	...	...	2	250	...	250	250
„ „ „ 49 N.W.														
Quarter sheets 47 S.W., 49 S.W., 124 S.E.	3	Do.	1=4	1=4	Do.	...	...	...	...	3	90	...	90	90
Total	5	...	...	...	...	...	...	...	...	5	340	...	340	340
General Maps.														
Afghanistan	15	Photo-zinco.	1=24	1=24	Impl.	19	12	16	8	...	144	...	144	144
Burma and adjacent countries	8	Do.	1=24	1=32	D. R.	11	11	4	2	...	200	...	200	200
Do. do.	...	Do.	„	„	...	...	...	...	6	...	300	...	300	300
India, 2nd edition	6	Litho.	1=32	1=32	D. E.	...	...	...	...	6	1,200	...	1,200	1,200
„ showing Railways, 2nd edition	6	Zinco.	1=32	1=32	Do.	...	...	6	...	...	...	...	...	...
„ „ Canals, „	6	Do.	1=32	1=32	Do.	...	...	6	...	...	...	...	...	...
„ „ Railways open to Traffic, &c.	...	Photo-zinco.	...	1=96	Atlas	...	...	...	4	...	150	...	150	150
„ Skeleton Railway Map	7	Do.	1=32	1=48	...	10	10	4	...	...	...	...	...	...
„ „ „ „	6	Do.	1=32	1=48	Atlas	4	20	4	4	...	400	...	400	400
„ „ „ „	...	Do.	1=32	1=64	D. R.	4	4	2	2	...	450	...	450	450
„ „ „ „	...	Do.	1=32	1=96	...	4	4	...	...	...	...	...	...	...
„ „ Hills and Outline	2	Do	1=32	1=48	...	3	3	3	...	...	...	...	...	...
„ showing gauges of Railways	1	Litho.	1=96	1=96	Atlas	...	...	...	...	1	100	...	100	100
„ showing progress of Surveys	1	Do.	1=128	1=128	Impl.	...	...	...	...	4	1,900	450	100	550
Total	58	...	...	...	...	55	64	45	26	11	4,844	450	3,044	3,494
Provincial Maps.														
Assam	1	Photo-zinco.	1=16	1=48	...	1	1	2	...	...	...	...	...	...
Do.	1	Litho.	1=16	1=16	D. I.	...	...	...	...	1	150	...	150	150
Bengal, Behar, Orissa and Chota Nagpore	2	Do.	1=16	1=16	Do.	...	...	...	...	2	300	...	300	300
Burma, portion of —	...	Blue print	...	...	...	...	...	...	...	...	...	...	...	...
Burma, (Upper) Preliminary, 3rd edition	...	Photo-zinco.	1=16	1=16	D. E.	...	...	...	2	...	35	...	35	35
„ 4th edition	2	Do.	1=16	1=16	„	6	6	2	2	...	65	...	65	65
„ 5th edition	1	Do.	1=16	1=16	„	4	4	1	2	...	256	...	256	256
„ „	...	Do.	1=16	1=16	„	...	...	...	1	...	225	...	225	225
Central Provinces	1	Litho.	1=80	1=80	½ F'cap	...	...	...	...	1	450	...	450	450
Eastern and Western Bengal, sheets Nos. 1 to 16.	16	Do.	1=8	1=8	Impl.	...	...	...	...	16	1,200	...	1,200	1,200
N. W. P. and Oudh	1	Do.	1=32	1=32	Do.	...	...	...	...	1	250	...	250	250
Punjab	1	Do.	1=80	1=80	½ F'cap	...	...	...	...	1	100	...	100	100
Total	26	...	...	...	...	11	11	5	7	22	3,031	...	3,031	3,031
Divisional Maps.														
Burdwan	...	Photo-zinco.	1=4	1=8	Atlas	...	...	...	1	...	150	...	150	150
Pegu, Sheets Nos. 1 to 4	4	Do.	1=4	1=4	D. E.	16	16	4	4	...	400	...	400	400
Total	4	...	...	...	...	16	16	4	5	...	550	...	550	550
District Maps.														
N. W. Provinces and Oudh—														
Agra	3	Photo-zinco.	1=1	1=2	...	6	6	3	...	...	...	...	...	...
„ part of, with new heading	1	Do.	2=1	1=1	...	2	2	1	...	...	...	...	...	...
Banda	...	Do.	1=1	1=2	...	...	...	...	...	...	200	...	200	200
Hamirpur	...	Do.	1=1	1=2	...	...	...	...	...	...	200	...	200	200
„ Map, new headings of	1	Do.	...	...	...	1	1	...	...	...	...	...	...	...
Assam—														
Sibsagar	1	Litho. from Atlas Sheets.	1=4	1=4	Atlas	...	...	...	...	1	150	...	150	150
Bengal—														
Chumparun, Mozufferpore and Sarun	3	Do.	1=4	1=4	Do.	...	...	...	...	3	450	...	450	450
Durbhunga	1	Do.	1=4	1=4	D. R.	...	...	...	...	1	150	...	150	150
Hazaribagh	1	Do.	1=4	1=4	Antiqn.	...	...	...	...	1	150	...	150	150
Monghyr	1	Do.	1=4	1=4	Atlas	...	...	...	...	...	...	...	...	...
Rungpore	1	Do.	1=4	1=4	D. E.	...	...	...	...	...	...	...	...	...
Khoolna and Shahabad	2	Do.	1=4	1=4	Atlas	...	...	...	...	2	40	...	40	40
Central Provinces—														
Chanda	1	Do.	1=4	1=4	Special	...	...	...	...	1	150	...	150	150
Jubbulpore	...	Do.	...	1=4	Antiqn.	...	...	...	...	1	20	...	20	20
Bengal—														
Purneah	1	Photo-zinco.	1=4	1=4	...	4	4	1	...	...	...	...	...	...
Shahabad and Tirhoot		Do.	1=4	1=4	D. E.	8	8	3	3	...	150	...	150	150

GRAPHIC OFFICE.

during the year 1888-89.

Type Printing.			Silver and other Printing.			Heliogravure and Electrotyping.				Photo-collotype.		Value.	Remarks.
Pages or items.	Pulls.	Copies.	Silver prints.	Blue prints.	Miscellaneous prints.	Plates.	Prints.	Photo. blocks.	Electrotypes.	Plates.	Prints.		
												R a. p.	
...	...	...	...	...	...	...	...	...	...	...	..	44 11 0	Transferred previously, but printed during the year.
...	...	...	...	...	...	...	...	...	...	...	...	19 14 0	Reprint.
...	...	...	...	...	...	...	...	...	...	...	...	64 9 0	
...	...	...	...	...	...	...	...	...	...	...	...	311 9 3	
...	...	...	...	...	...	...	...	...	...	...	...	216 15 9	
...	...	...	...	...	...	...	...	...	...	...	...	75 13 9	250 copies reprinted and 50 unpublished proofs.
...	...	...	...	...	...	...	...	...	...	...	...	1,619 9 0	Transferred previously, but printed during the year.
...	...	...	...	...	...	...	...	...	...	...	...	48 0 0	
...	...	...	...	...	...	...	...	...	...	...	...	48 0 0	
...	...	...	...	...	...	...	...	...	...	...	...	20 4 0	Reprint.
...	...	...	...	...	...	...	...	...	...	...	...	141 9 6	Proofs sent for examination.
...	...	...	...	...	...	...	...	...	...	...	...	309 3 6	16 transfers taken from old negatives.
...	...	...	...	...	...	...	...	...	...	...	...	175 5 0	
...	...	...	...	...	...	...	...	...	...	...	...	36 0 0	
...	...	...	...	...	...	...	...	...	...	...	...	48 2 3	Experimental.
...	...	...	...	...	...	...	...	...	...	...	...	31 9 0	
...	...	...	...	...	...	...	...	...	...	...	...	288 3 0	
..	...	...	...	...	...	...	...	...	...	...	...	3,370 4 0	
...	...	...	...	...	...	...	...	...	...	...	...	23 15 9	
...	...	...	...	...	...	...	...	...	...	...	...	155 0 0	Transferred from Copper-plates. Additions and corrections made on stone.
...	...	...	...	...	...	...	...	...	...	...	...	577 12 0	
...	...	...	...	4	...	...	...	...	...	...	...	4 12 9	
...	...	...	...	...	...	...	...	...	...	...	...	7 9 6	Reprint.
...	...	...	...	...	...	...	...	...	...	...	...	94 9 9	
...	...	...	...	...	...	...	...	...	...	...	...	115 9 3	50 copies reprinted and 6 unpublished proofs.
...	...	...	...	...	...	...	...	...	...	...	...	8 10 6	25 unpublished proofs.
...	...	...	...	...	...	...	...	...	...	...	...	35 11 9	
...	...	...	...	...	...	...	...	...	...	...	...	241 0 0	Reprints.
...	...	...	...	...	...	...	...	...	...	...	...	33 14 0	
...	...	...	...	...	...	...	...	...	...	...	...	26 11 0	
...	...	...	...	4	...	...	...	...	...	...	...	1,325 3 6	
...	...	...	...	...	...	...	...	...	...	...	...	28 12 0	
...	...	...	...	...	...	...	...	...	...	...	...	336 10 9	
...	...	...	...	...	...	...	...	...	...	...	...	365 6 9	
...	...	...	...	...	...	...	...	...	...	...	...	91 3 3	
...	...	...	...	...	...	...	...	...	...	...	...	30 9 6	
...	...	...	...	...	...	...	...	...	...	...	...	72 11 6	For record in M. R. I. O.
...	...	...	...	...	...	...	...	...	...	...	...	71 10 3	
...	...	...	...	...	...	...	...	...	...	...	...	9 9 6	
...	...	...	...	...	...	...	...	...	...	...	...	187 15 0	Transferred previously, but printed during the year.
...	...	...	...	...	...	...	...	...	...	...	...	460 1 0	
...	...	...	...	...	...	...	...	...	...	...	...	39 4 0	
...	...	...	...	...	...	...	...	...	...	...	...	78 8 0	
...	...	...	...	...	...	...	...	...	...	...	...	189 4 0	Transferred from Copper-plate, not yet printed.
...	...	...	...	...	...	...	...	...	...	...	...	87 4 0	
...	...	...	...	...	...	...	...	...	...	...	...	16 0 0	Reprint.
...	...	...	...	...	...	...	...	...	...	...	...	184 5 0	Transferred previously, but printed during the year.
...	...	...	...	...	...	...	...	...	...	...	...	15 12 0	Reprint.
...	...	...	...	...	...	...	...	...	...	...	...	51 9 6	
...	...	...	...	...	...	...	...	...	...	...	...	153 3 0	

Statement of Departmental Work done

Specification of Plate or Print.	Sheets or subjects in hand.	Nature of work.	Scale of Map.		Size.	Negatives and transparencies.	Photo-Zincographic and Lithographic Printing.							
			Original.	Reproduced.			Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Stones.	Pulls.	Number of copies.		
												Colored.	Uncolored.	Total.
District Maps—*continued.*			In. M.	In. M.										
Burma—														
Mergui and Minbu	6	Photo zinco.	1=4	1=4	...	16	16	2	...	...	...	...	...	...
Punjab—														
Bannu, Dera-Ghazi Khan, Delhi and Peshawar	...	Do.	1=4	1=4	Atlas Impl.	...	...	...	5	...	1,450	...	1,450	1,450
North-Western Provinces—														
Ghazipur	...	Litho.	1=4	1=4	S. R.	..	...	...	...	1	150	...	150	150
Bengal—														
Gangpur	1	Do.	1=8	1=8	...	1	1	1	...	...	...	...	...	...
Tributary State of Chota-Nagpur														
Gya, Midnapore, Singbhoom and Sonthal-Pergunnahs	4	Do.	1=8	Various	...	4	4	1	...	...	...	...	...	...
Hill Territory of British Sikkim, district Darjeeling	4	Do.	2=1	2=1	D. E. D. Impl.	16	16	4	4	...	600	...	600	600
N. W. Provinces and Oudh—														
Bahraich, Dehra Dun, Lucknow, Partabgarh and Sultanpur	5	Photo-zinco.	1=4	1=8	...	5	5	1	...	...	...	...	...	...
Agra, Alighur, Ghazipur and Mozaffernagar	...	Do.	...	...	...	...	...	1	...	...	...	...	...	...
Fatehpur, Furruckabad, Jaunpur and Kheri	4	Do.	1=8	1=8	...	2	2	1	...	...	...	...	...	...
Total	46	...	...	...	...	65	65	19	12	11	3,860	...	3,860	3,860
Plans of Cities, Cantonments, &c.														
Baroda City	4	Photo-zinco.	1=200ft.	$\frac{5}{32}$	D. E.	4	4	1	1	...	400	...	400	400
Benares, City and Cantonment	...	...	...	...	...	...	...	...	10	...	50	...	50	50
Deesa Cantonment	16	Do.	1=8	1=8	...	18	18	8	8	...	800	...	800	800
Mandalay—														
Sheets Nos. 1, 2 and 3	3	Do.	6=1	6=1	...	12	12	3	3	...	300	...	300	300
Sabathu Cantonment	...	Do.	...	...	D. E.	...	...	...	3	...	225	...	225	225
Simla Guide Map	18	Do.	24=1	$\frac{1}{4}$	D. I.	18	18	1	1	...	250	...	250	250
Town of Calcutta, in 2 sheets	2	Litho.	6=1	6=1	D. E.	...	...	...	...	4	200	50	...	50
Ditto	1	Do.	3=1	3=1	S. R.	...	...	...	...	1	50	50	...	50
Hutted Camps of Baragali, Kalabagh and Khyragali, district Hazara; and Thoba, district Rawalpindi	4	Photo-zinco.	12=1	12=1	...	16	16	...	...	...	...	...	...	...
Total	48	...	...	...	...	68	68	13	26	5	2,275	100	2,025	2,125
Standard Sheets.														
Assam—														
Districts Darrang and Kamrup—														
Sheet No. 39	4	Photo-zinco.	2=1	1=1	...	4	4	1	...	...	...	...	...	...
Khasia and Garo Hills—														
Sheets Nos. 83, 84, 87, and 88	4	Do.	1=2	1=1	...	4	4	1	...					
Bengal—										...	...	...	...	...
District Cuttack—														
Sheets Nos. 194 and 195	8	Do.	2=1	1=1	...	8	8	2	...	...	...			
District Cuttack—												...	...	...
Sheet No. 196	...	Do.	...	...	...	...	...	...	1	...	150	...	150	150
District Hooghly—														
Sheets Nos. 4 and 6	8	Do.	2=1	1=1	...	8	8	2	...	...	...	...	...	...
District Jalpaiguri—														
Sheet No. 293	1	Litho.	1=1	1=1	D. R.	...	...	...	...	1	100	...	100	100
District Mymensingh—														
Sheet No. 364	1	Do.	1=1	1=1	,,	...	...	...	...	1	200	...	200	200
District Mymensingh—														
Sheets Nos. 347, 360 and 363	3	Do.	1=1	1=1	,,	...	...	...	...	...	...	...	...	...
District 24-Pergunnahs—														
Sheet No. 1	1	Photo-zinco	1=1	1=1	...	4	4	1	...	...	...	...	...	...
Bombay—														
Bombay Native States and Khandesh—														
Sheet No. 16	...	Do.	1=1	1=1	D. R.	...	...	...	1	...	75	...	75	75
Parts of the Panch Mehals Collectorate and of the Rewa Kantha Agency—														
Sheet No. 181														
District Belgaum—	16	Do.	2=1	1=1	...	16	16	4	4	...	600	...	600	600
Sheets Nos. 102, 118 and 119														
District Belgaum—														
Sheets Nos. 123, 305 and 306														
District Dharwar, Sangli and Jamkhandi States—	13	Do.	2=1	1=1	...	18	18	4	...	...	...	...	...	
Sheet No. 307														
District Belgaum and Kolhapur—														
Sheet No. 243	...	Do.	2=1	1=1	D. R.	...	...	...	1	...	150	...	150	150
District Belgaum—														
Sheet No. 216 N. E.	1	Do.	2=1	2=1	...	4	4	1	...	...	...	...	...	...

GRAPHIC OFFICE.

during the year 1888-89—continued.

Type Printing.			Silver and other Printing.			Heliogravure and Electrotyping.				Photo-collotype.		Value.	Remarks.
Pages or items.	Pulls.	Copies.	Silver prints.	Blue prints.	Miscellaneous prints.	Plates.	Prints.	Photo blocks.	Electrotypes.	Plates.	Prints.		
												R a. p.	
...	...	...	...	...	...	...	...	...	...	...	...	199 3 3	
...	...	...	...	...	...	...	...	...	...	...	...	313 13 6	Reprint.
...	...	...	...	...	...	...	...	...	...	...	...	72 12 0	Drawn previously, but printed during the year.
...	...	...	...	...	...	...	...	...	...	...	...	14 6 6	
...	...	...	...	...	...	...	...	...	...	...	...	49 3 3	
...	...	...	...	...	...	...	...	...	...	...	...	424 0 9	
...	...	...	...	...	...	...	...	...	...	...	...	57 9 6	
...	...	...	...	...	...	...	...	...	...	...	...	6 9 6	
...	...	...	...	...	...	...	...	...	...	...	...	33 0 0	
...	...	...	...	...	...	...	...	...	...	...	...	2,909 7 9	
...	...	...	...	...	...	...	...	...	...	...	...	98 7 6	
...	...	...	...	...	...	...	...	...	...	...	...	43 7 6	
...	...	...	...	...	...	...	...	...	...	...	...	504 10 0	
...	...	...	...	...	...	...	...	...	...	...	...	234 4 0	
...	...	...	...	...	...	...	...	...	...	...	...	63 15 6	
...	...	...	...	...	...	...	...	...	...	...	...	261 0 0	
...	...	...	...	...	...	...	...	...	...	...	...	43 15 0	
...	...	...	...	...	...	...	...	...	...	...	...	11 5 0	
...	...	...	...	...	...	...	...	...	...	...	...	182 6 3	
...	...	...	...	...	...	...	...	...	...	...	...	1,443 6 9	
...	...	...	...	...	...	...	...	...	...	...	...	52 12 9	
...	...	...	...	...	...	...	...	...	...	...	...	52 12 9	
...	...	...	...	...	...	...	...	...	...	...	...	104 11 3	
...	...	...	...	...	...	...	...	...	...	...	...	40 15 0	
...	...	...	...	...	...	...	...	...	...	...	...	104 11 3	
...	...	...	...	...	...	...	...	...	...	...	...	41 14 0	Reprint.
...	...	...	...	...	...	...	...	...	...	...	...	414 15 0	Drawn previously, but printed during the year.
...	...	...	...	...	...	...	...	...	...	...	...	1,709 13 0	Drawn during the year, not yet printed.
...	...	...	...	...	...	...	...	...	...	...	...	54 0 0	
...	...	...	...	...	...	...	...	...	...	...	...	18 15 6	
...	...	...	...	...	...	...	...	...	...	...	...	363 15 0	
...	...	...	...	...	...	...	...	...	...	...	...	227 15 9	
...	...	...	...	...	...	...	...	...	...	...	...	40 15 0	
...	...	...	...	...	...	...	...	...	...	...	...	52 12 9	

Statement of Departmental work done

Specification of Plate or Print.	Sheets or Subjects in hand.	Nature of work.	Scale of Map. Original.	Scale of Map. Reproduced.	Size.	Negatives and transparencies.	Photo-zincographic and Lithographic Printing. Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Stones.	Pulls.	Number of copies. Colored.	Uncolored.	Total.
Standard Sheets—*continued.*			In. M.	In. M.										
Bombay—continued.														
District Belgaum—														
Sheets Nos. 160 N.E./3 N.W./1,3 S.E./1,3,4 S.W./1,2,3,4	10	Photo-zinco	4=1	4=1	...	41	41	10	...	...	...	...	...	...
Burma—														
District Bassein—														
Sheets Nos. 143 and 188														
District Hanthawaddy—														
Sheet No. 233	...	Do.	2=1	1=1	D. R.	...	...	...	3	...	450	...	450	450
Districts Hanthawaddy and Tharrawaddy—														
Sheet No. 278														
District Pegu—														
Sheet No. 280	8	Do.	2=1	1=1	D. R.	8	8	2	2	...	300	...	300	300
District Akyab—														
Sheets Nos. 26, 28, 43, 45														
District Bassein—														
Sheets Nos. 142, 187														
District Hanthawaddy—														
Sheet No. 234	32	Do.	2=1	1=1	...	32	32	8	...	...	...	...	...	...
Districts Hanthawaddy, Pegu and Rangoon—														
Sheet No. 281														
District Akyab—														
Sheet No. 47	1	Do.	1=1	1=1	...	4	4	1	...	...	...	...	...	...
District Prome—														
Sheet No. 179 N.E./1,3 S.E./4														
Districts Tharrawaddy and Prome—														
Sheet No. 180 N.E./2 S.E./3														
Sheet No. 181 N.E./1,3														
Sheet No. 226 N.E./3 S.E./1,3,4 S.W./2,3,4	21	Do.	4=1	4=1	D. R.	82	82	20	20	...	2,050	...	2,050	2,050
Districts Tharrawaddy, Prome and Toungoo—														
Sheet No. 227 N.E./2,4 N.W./1,2,3 S.E./2 S.W./2														
Central India and Rajputana—														
Sheets No. 387, 415, 416 and 417	...	Do.	1=1	1=1	D. R.	...	...	...	4	...	600	...	600	600
„ „ 403	1	Do.	1=1	1=1	...	4	4	1	...	...	...	...	...	...
Central Provinces—														
Sheet No. 12	...	Do.	1=1	1=1	D. R.	...	...	...	1	...	100	...	100	100
Mysore—														
Sheets No. 7, 8, 15, 34, 42, 51, 52, 53, 58, 59, 60 and 61	12	Do.	1=1	1=1	...	48	48	12	...	...	...	...	...	...
N. W. Provinces and Oudh—														
Districts Gonda and Fyzabad—														
Sheet No. 162														
District Mirzapur—														
Sheet No. 171														
Districts Jaunpur, Benares and Mirzapur—	...	Do.	2=1	1=1	D. R.	...	...	...	5	...	750	...	750	750
Sheet No. 181														
Districts Ballia and Gorakhpur—														
Sheets No. 216 and 217														
District Mirzapur—														
Sheets No. 170														
Districts Benares and Mirzapur	8	Do.	2=1	1=1	D. R.	8	8	2	2	...	300	...	300	300
Sheet No. 197														
Districts Agra, Aligarh, Etah and Muttra—														
Sheet No. 36														
Districts Aligarh, Budaun and Etah—														
Sheet No. 52														
Districts Alighar, Etah and Mainpuri—														
Sheet No. 53														
Districts Ballia and Gorakhpur—	50	Do.	2=1	1=1	...	57	57	14	...	...	...	...	...	...
Sheets Nos. 207 and 208														
Districts Benares and Mirzapur—														
Sheet No. 182														
District Basti—														
Sheets Nos. 49, 163, 173, 174, 175, 176, 191 and 192														
Oudh—														
District Unao—														
Sheet No. 107	1	Litho	1=1	...	D. R.	...	...	...	...	1	200	...	200	200
District Kheri—														
Sheet No. 100	1	Do.	1=1	...	...	...	...	...	...	...	...	...	...	...

GRAPHIC OFFICE.

during the year 1888-89—continued.

Type Printing.			Silver and other Printing.			Heliogravure and Electrotyping.				Photo-collotype.		Value.	Remarks.
Pages or items.	Pulls.	Copies.	Silver prints.	Blue prints.	Miscellaneous prints.	Plates.	Prints.	Photo. blocks.	Electrotypes	Plates.	Prints.		
												R a. p.	
...	...	...	...	...	...	...	...	...	...	...	....	536 6 3	
...	...	...	...	...	...	...	...	...	...	...	...	122 3 0	
...	...	...	...	...	...	...	...	...	...	...	...	188 7 6	
...	...	...	...	...	...	...	...	...	...	...	...	422 12 6	
...	...	...	...	...	...	...	...	...	...	...	...	52 12 9	
...	...	...	...	...	...	...	...	...	...	...	...	1,588 15 9	25 unpublished proofs of each of the Sheets 179 $\frac{N.E.,}{1}$, $\frac{S.E.,}{4}$; 180 $\frac{N.E.,}{2}$ $\frac{S.E.,}{3}$; 181 $\frac{N.E.,}{1}$; 226 $\frac{S.W.}{3}$; 227 $\frac{N.W.,}{1}$ $\frac{N.E.}{2,4}$
...	...	...	...	...	...	...	...	...	...	...	...	151 12 0	
...	...	...	...	...	...	...	...	...	...	...	...	52 12 0	
...	...	...	...	...	...	...	...	...	...	...	...	25 3 9	
...	...	...	...	...	...	...	...	...	...	...	...	634 12 9	
...	...	...	...	...	...	...	...	...	...	...	...	208 11 0	
...	...	...	...	...	...	...	...	...	...	...	...	191 7 6	
...	...	...	...	...	...	...	...	...	...	...	...	750 3 9	
...	...	...	...	...	...	...	...	...	...	...	...	308 12 0	Drawn on transfer paper.
...	...	—	...	...	...	...	...	...	...	...	...	228 0 0	Ditto, — not yet printed.

Statement of Departmental Work done

Specification of Plate or Print.	Sheets or Subjects in hand.	Nature of work.	Scale of Map.		Size.	Negatives and transparencies.	Photo-zincographic and Lithographic Printing.							
			Original.	Reproduced.			Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Stones.	Pulls.	Number of Copies.		
												Colored.	Uncolored.	Total.
Standard Sheets—*contd.*														
Oudh—continued.			In. M.	In. M.										
Districts Fyzabad and Kheri—Sheets Nos. 98, 99, 113 and 192	4	Litho.	1=1	1=1	...	...	...	...	...	...	...	...	...	...
Districts Bahraich, Gonda, Hardoi and Kheri—Sheets Nos. 101, 103 and 147	3	Do.	1=1	1=1	D. R.	...	...	...	...	3	600	...	600	600
N. E. Trans-frontier—6 Maps	3	Photo-zinco	1=4	1=4	,,	12	12	3	6	...	750	...	750	750
3 ,,	3	Ditto	1=8	1=8	,,	12	12	3	3	...	450	...	450	450
N. W. Trans-frontier—24 Maps	13	Photo-zinco. Litho.	1=4	1=4	,,	41	45*	11	25	11†	5,125	...	5,125	5,125‡
2 Maps	2	Photo zinco	1=4	1=1	...	7	7	2	...	...	...	...	...	...
1 Map	...	Do.	2=1	2=1	D. R.	...	...	...	1	...	150	...	150	150
2 Maps	1	Do.	2=1	1=1	...	4	4	1	...	...	...	...	...	...
9 Maps	6	Do.	1=2	1=2	D. R.	24	24	7	7	...	1,062	...	1,062	1,062
1 Map	1	Do.	1=1	1=1	...	4	4	1	...	...	...	...	...	...
Punjab—Districts Kalsia and Umballa—Sheet No. 135; Districts Faridkot and Ferozepore—Sheets Nos. 225 and 226; Districts Gurdaspur, Hoshiarpur, Jullunder and Kapurthala States—Sheet No. 249; Districts Ludhiana and Sikh States—Sheet No. 453; Districts Karnal and Umballa—Sheets Nos. 293 and 294; Districts Ludhiana and Sikh States—Sheet No. 270	24	Do.	2=1	1=1	...	24	30	7	...	...	...	...	...	...
District Hazara—Sheets Nos. 11, 14 and 15; Districts Hissar and Patiala—Sheets Nos. 241 and 242; Districts Hoshiarpur and Jullunder—Sheet No. 267; Districts Jullunder, Ludhiana and Umballa—Sheet No. 269; Districts Hoshiarpur and Umballa—Sheet No. 290; Districts Kalsia State, Patiala and Umballa—Sheets Nos. 291 and 292; District Umballa—Sheets Nos. 289, 313; Districts Kalsia State and Umballa—Sheets Nos. 314, 336	4	Do.	1=1	1=1	D. R.	4	8	1	1	...	150	...	150	150
	...	Do.	2=1	1=1	D. R.	...	...	...	14	...	1,875	...	1,875	1,875
Upper Burma (*S. E. Trans-frontier Series*)—Sheets Nos. 1 N. E., S. E., 2 N. E.; 4 N. E., N. W., S. E.; S. W.; 5 N. E., N. W., S. E., S. W.; 6 N. W.; 15 S. E.	16	Do.	1=4	1=4	,,	57	63	15	30	...	2,325	...	2,325	2,385
Sheets Nos. 1, 2 N. E.	2	Do.	1=4 1=8	1=1	...	8	8	2	...	...	...	...	...	...
Total	287	...	...	...	...	547	567	139	131	7	18,512	...	18,512	18,512
Index Maps.														
Of various survey operations and standard sheets	67	Photo-zinco Litho.	...	...	...	47	52	54	53	20	25,145	1,420	19,430	20,850
Total	67	...	...	...	...	47	52	54	53	20	25,145	1,420	19,430	20,850
Technical Charts.														
N. E., N. W., S. E. and S. W., Quadrilateral and Triangulation East of 92°	11	Photo-zinco	Var	½ & ¼	...	12	12	4	...	...	...	...	...	...
Plan of the Trigonometrical operations in the Nizam's Dominions, extending from Kurnool to Godavary	...	Do.	1=8	1=8	...	...	...	...	1	...	25	...	25	25
Preliminary Chart of the secondary Triangulation in district Akyab	1	Do.	1=4	1=4	...	8	8	1	...	...	...	...	...	...
Southern Trigon and Index to the sections in which the series of the principal Triangulation have been grouped for reduction	3	Do.	Var	½	...	3	3	1	...	...	...	...	...	...
Triangulation Chart of Baluchistan Survey Degree-Sheet $\frac{21 \text{ S. E.}_2}{2, 3, 4}$	2	Do.	1=4	1=4	...	4	4	2	1	...	25	...	25	25
Triangulation Chart of Bhopal and Malwa Survey Degree-Sheet XIV	1	Do.	1=2	1=2	...	4	4	1	...	...	...	...	...	...

GRAPHIC OFFICE.

during the year 1888-89—continued.

Type Printing.			Silver and other Printing.			Heliogravure and Electro-typing.				Photo-collotype.		Value.	Remarks.
Pages or items.	Pulls.	Copies.	Silver prints.	Blue prints.	Miscellaneous prints.	Plates.	Prints.	Photo. Blocks.	Electrotypes.	Plates.	Prints.		
												R a. p.	
...	...	...	...	...	...	...	...	...	...	...	...	938 14 0	Drawn, not yet printed.
...	...	...	...	...	...	...	...	...	...	...	...	684 4 6	Drawn previously, but printed during the year.
...	...	...	...	...	...	...	...	...	...	...	...	365 9 9	25 unpublished proofs.
...	...	...	...	...	...	...	...	...	...	...	...	272 3 3	
...	...	...	...	5	...	...	...	...	...	...	...	1,826 10 6	* 4 transfers from old negatives. † Transferred from Copper-plates. ‡ 2,700 copies reprinted.
...	...	...	...	...	...	...	...	...	...	...	...	94 12 9	Confidential.
...	...	...	...	...	...	...	...	...	...	...	...	37 15 0	
...	...	...	...	...	...	...	...	...	...	...	...	52 12 9	Confidential.
...	...	...	...	...	...	...	...	...	...	...	...	593 8 3	3 maps confidential.
...	...	...	...	...	...	...	...	...	...	...	...	52 12 9	Confidential.
...	...	...	...	...	...	...	...	...	...	...	...	353 10 9	6 transfers taken from old negatives.
...	...	...	...	...	...	...	...	...	...	...	...	114 11 9	
...	...	...	...	...	...	...	...	...	...	...	...	531 4 3	
...	...	...	...	...	...	...	...	...	...	...	...	1,521 11 3	14 plates reprinted.
...	...	...	...	...	...	...	...	...	...	...	...	105 9 6	
...	...	...	...	5	...	...	...	...	...	...	...	16,290 14 0	
...	...	...	...	...	...	...	...	...	...	...	...	2,474 11 0	
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...	...	...	...	...	...	...	...	...	...	...	...	136 15 6	
...	...	...	...	...	...	...	...	...	...	...	...	5 9 0	
...	...	...	...	...	...	...	...	...	...	...	...	99 9 6	
...	...	...	...	...	...	...	...	...	...	...	...	37 14 6	
...	...	...	...	...	...	...	...	...	...	...	...	58 13 9	
...	...	...	...	...	...	...	...	...	...	...	...	43 12 9	

Statement of Departmental Work done

Specification of Plate or Print.	Sheets or subjects in hand.	Nature of work.	Scale of Map. Original.	Scale of Map. Reproduced.	Size.	Negatives and transparencies.	Photo-zincographic and Lithographic Printing. Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Stones.	Pulls.	Number of copies. Colored.	Uncolored.	Total.
			In. M.	In. M.										
Technical Charts—*continued.*														
Triangulation Chart of the country adjoining the Hill Tracts, Lushai Expedition	1	Photo-zinco.	1=4	1=4	...	1	1	1	...	...	...	...	...	...
Total	19	...	...	...	...	32	32	10	2	...	50	...	50	50
Miscellaneous Maps and Plans.														
Acre-Comb, scale 2″=1 M.	1	Litho.	...	...	R 8vo.	...	...	...	...	1	125	...	500	500
Black Mountain & Country adjoining Agror	1	Litho.	1=2	...	Atlas	...	...	...	...	1	25	...	25	25
Ditto ditto	1	Photo-zinco.	1=2	1=4	...	1	...	...	...	...	...	...	...	...
Chin Hills, part of Karenni, and Bhamo District. Preliminary Map of	3	Do.	1=4	1=4	...	11	11	3	6	...	750	...	750	750
Chanda District, Index to the Traverse Survey in	1	Do.	4=1	¼	...	1	...	...	...	...	...	...	...	...
Chittagong, Map of	...	Blue print.	...	...	...	...	...	...	...	...	...	...	...	...
Classified Maps of Forest and Soil	2	Litho.	...	...	...	...	...	...	...	...	...	...	...	...
Conventional Signs for Cadastral Maps	1	Photo-zinco.	...	⅛	...	1	...	...	...	...	...	...	...	...
Ditto ditto in Nagri character	1	Litho.	...	...	½ S. R.	...	...	...	...	1	500	...	500	500
Conventional Signs	1	Do.	...	...	...	...	...	...	...	...	...	...	...	...
Ditto for Military Topography	1	Do.	...	...	...	...	...	...	...	1	100	...	100	100
Country to miles round Delhi, Skeleton Map of	1	Photo-zinco.	1=1	1=1	...	2	2	1	1	...	125	...	125	125
Countries on the N. W., Frontier of India showing principal routes, Skeleton Map of	...	Do.	...	...	...	...	...	...	...	...	5	...	5	5
Countries surveyed by Lushai Detachment	1	Blue print.	1=4	1=8	...	1	...	...	...	...	...	...	...	...
Country adjoining Chittagong Hill Tracts.	1	Do.	1=4	1=4	...	1	3	1	1	...	160	...	160	160
,, surveyed by Ahmed Ali Khan	1	Do.	1=8	1=8	...	4	4	1	1	...	79	...	79	79
Drawings illustrating M. I. O. Catalogue	12	Wood-cut.	...	...	...	...	...	...	...	...	...	...	...	...
Eastern Frontier of Bengal	1	Photo-zinco.	1=4	½	...	2	2	1	...	...	...	...	...	...
External Trade Route Map of Bengal	1	Litho.	1=16	...	Atlas	...	...	...	...	1	10	...	10	10
Exhibition Medal, Obverse and Reverse	...	Electrotype	...	...	...	...	...	...	...	...	...	...	...	...
India, Sheets Nos. 1 and 3	1	Do.	1=32	1=32	...	1	...	...	...	...	...	...	...	...
India, 64 mile (without hills), Sheet No. 1	1	Do.	...	...	...	...	...	...	...	...	...	...	...	...
India, 96 mile	...	Do.	...	...	...	...	...	...	...	...	...	...	...	...
Punjab, Map of	2	Do.	...	...	...	1	...	...	...	...	...	...	...	...
Hazara, Sheets Nos. 3, 4, 6 to 9, 11, 12, 14 and 15	...	Photo-zinco.	...	...	...	...	...	...	10	...	500	...	500	500
Hazara Field Force, Map illustrating the Signalling and Telegraph operations of	...	Do.	...	...	...	...	...	...	...	...	5	...	5	5
Group of Mango trees	...	Heliogravure	...	...	...	...	...	...	...	...	...	...	...	...
Lady Dufferin's Portrait	...	Do.	...	...	...	...	...	...	...	...	...	...	...	...
Levelling Staves	1	Do.	...	...	...	3	...	...	...	...	...	...	...	...
Lord Dufferin's Portrait	...	Do.	...	...	...	2	...	...	...	...	...	...	...	...
Specimen of brush-shading by air-brush	1	Do.	...	...	...	3	...	...	...	...	...	...	...	...
Tomb of It-mád-ud-dowla	...	Do.	...	...	...	...	...	...	...	...	...	...	...	...
Views and Plans of new offices	56	Do.	...	...	...	63	...	...	...	...	...	...	...	...
Hissar District, Alphabetical list of villages	1	Photo-zinco.	...	...	...	4	4	1	...	...	...	...	...	...
Hyderabad Assigned Districts, map of	1	Litho.	1=80	1=80	...	...	...	...	...	...	...	...	...	...
Jami Masjid, Jaunpur	...	Blue pint.	...	...	...	...	...	...	...	...	...	...	...	...
Kalinjar, Plan of the Town and Fort of	...	Photo-zinco.	3=1	1½	...	...	2	1	1	...	250	...	500	500
Khoolna, Civil Station of	...	Do.	...	...	...	...	...	...	...	...	10	...	10	10
,, Municipal limits of	...	Do.	...	...	...	...	...	...	...	...	10	...	10	10
Killa Angul	1	Do.	1=1	1=1	...	9	9	4	...	...	...	...	...	...
,, ,, heading in Ooria characters	1	Do.	...	...	...	1	1	1	...	...	...	...	...	...
Killa Talchiri, Cuttack Tributary Mahal	1	Do.	1=1	1=1	...	4	4	2	...	...	...	...	...	...
Kula Kangri Peak B. of Mr. Lane by Rin-zin Nimgyal 1885	3	Litho.	...	...	...	...	...	...	...	1	30	...	90	90
Levelling staves	1	Photo-zinco.	...	...	...	1	1	1	1	...	500	...	1,000	1,000
,, ,, figures 1 to 14	5	Litho.	...	...	½ S. R.	...	...	...	...	8	3,200	1,100	1,000	2,100
Lushai and adjoining Hill Tracts	3	Photo-zinco.	1=8	1=8	...	3	12*	3	2	...	335	...	335	335
Mandalay Survey, Index map of	...	...	...	...	...	...	...	...	1	...	20	...	20	20
Map headings for N. W. Trans-frontier and Baluchistan Topographical Survey sheets	1	Litho.	...	...	...	...	...	...	...	1	50	...	50	50
Mullogori Country, sketch map of	...	Blue print.	...	...	...	...	...	...	...	...	...	...	...	...
Office Seal for Survey of India Offices	5	Litho.	...	...	...	...	...	...	...	5	2,038	...	2,038	2,038
Ordnance Survey of Ireland Sheets Nos. 89, 117, 142, 172 and 300	6	Photo-zinco.	...	...	...	13	13	4	...	...	...	...	...	...
Pamban Reserve Forest Madura, Madras	2	Do.	4=1	4=1	...	8	8	2	1	...	100	...	100	100
Panorama of Snows	4	Do.	...	...	...	5	5	2	...	...	...	...	...	...
Plan of Mandalay showing Cantonment boundaries and disposition of troops	1	Litho.	...	...	...	...	...	...	...	1	55	...	55	55
Plan showing the land required by Government at Chandbally	...	Photo-zinco.	...	...	...	...	...	...	...	...	10	...	10	10
Plans and Drawings of office machinery	1	Do.	...	...	...	1	...	1	...	...	...	...	...	...
Quetta and Pishin	...	Do.	...	...	...	...	...	...	2	...	24	...	24	24
Rawalpindi District (without numbers)	...	Do.	...	...	...	...	...	...	1	...	150	...	150	150
Reconnaissance Map of Northern Brigade, Upper Burma Field Force	...	Do.	...	...	...	...	...	...	...	...	10	...	10	10
Reconnaissance of Road between Demagri Stockade and Howsata's village	2	Do.	1=2	1=2	...	2	1	1	2	...	85	...	85	85
Reduction of Standard sheets to Atlas scale	203	Blue print.	...	...	...	202	...	...	...	...	...	...	...	...
Reference for Maps	1	Litho.	...	...	...	...	...	...	...	1	50	...	50	50
Ruby Mines Tract, Upper Burma	5	Photo-zinco.	6=1 / 2=1	6=1 / 2=1	...	20	20	5	5	...	250	...	250	250
Ruled sheets for Field Book	1	Litho.	...	...	...	...	...	...	...	1	30	...	*15	15
Scale 16″ = 1 mile	3	Do.	...	...	...	...	...	...	...	3	840	...	1,640	1,640
,, of Local Nals	1	Do.	...	...	...	...	...	...	...	...	...	...	...	...

GRAPHIC OFFICE.

during the year 1888-89—continued.

Type Printing.			Silver and other Printing.			Heliogravure and Electrotyping.				Photo-collotype.		Value.	Remarks.
Pages or items.	Pulls.	Copies.	Silver prints.	Blue prints.	Miscellaneous prints.	Plates.	Prints.	Photo. Blocks.	Electrotypes.	Plates.	Prints.		
												R a. p.	
...	...	...	...	...	...	...	...	...	...	...	...	18 9 6	
...	...	...	...	...	...	...	...	...	...	...	...	401 4 0	
...	...	...	...	...	...	...	...	...	...	...	...	16 0 0	
...	...	...	...	...	...	...	...	...	...	...	...	18 12 0	
...	...	...	...	...	...	...	...	...	...	...	...	5 6 3	
...	...	...	...	...	...	...	...	...	...	...	...	332 15 0	600 copies reprinted.
...	...	...	...	6	...	...	...	...	...	...	...	6 14 3	
...	...	...	...	3	...	...	...	...	...	...	...	3 7 3	Reprint.
...	...	...	...	...	...	...	...	...	...	...	...	66 9 0	Not yet printed.
...	...	...	...	1	...	...	...	...	...	...	...	7 12 9	
...	...	...	...	...	...	...	...	...	...	...	...	135 0 0	
...	...	...	...	...	...	...	...	...	...	...	...	79 4 0	Not yet printed.
...	...	...	...	...	...	...	...	...	...	...	...	30 2 0	
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...	...	...	...	...	...	...	...	...	...	...	...	0 13 6	For record in M. R. I. O.
...	...	...	...	4	...	...	...	...	...	...	...	7 12 9	
...	...	...	...	...	...	...	...	...	...	...	...	74 6 0	
...	...	...	...	...	...	...	...	...	...	...	...	69 0 9	
...	...	...	...	...	...	...	...	...	...	...	...	91 2 0	
...	...	...	...	...	...	...	...	...	...	...	...	32 6 3	
...	...	...	...	...	...	...	...	...	...	...	...	10 9 0	
...	...	...	...	...	...	...	...	...	2	...	...	10 0 0	Matrix.
...	...	...	...	...	...	...	...	...	3*	...	...	537 0 0	*2 do.
...	...	...	...	...	...	...	...	...	1	...	...	110 0 0	Duplicate.
...	...	...	...	...	...	...	...	...	1	...	...	124 2 0	Matrix.
...	...	...	...	...	...	...	...	...	2	...	...	66 0 0	Do.
...	...	...	...	...	...	...	...	...	...	...	...	128 3 0	Reprint.
...	...	...	...	...	...	...	...	...	...	...	...	0 8 3	For record in M. R. I. O.
...	...	...	...	...	...	1	1	...	...	...	...	30 0 0	
...	...	...	...	...	...	1	252	...	...	...	...	78 0 0	For office record and use.
...	...	...	...	...	...	1	1	...	...	...	...	60 0 0	Pigment-print.
...	...	...	...	...	...	1	33	...	...	...	...	45 7 9	
...	...	...	...	...	...	1	4	...	...	...	...	50 0 0	
...	...	...	...	...	...	...	100	...	...	...	...	12 0 0	
...	...	...	119	2	...	3	56	...	...	...	...	416 11 0	
...	...	...	...	...	...	...	...	...	...	...	...	54 0 0	
...	...	...	...	...	...	...	...	...	...	...	...	28 3 0	Additions and corrections made on stone.
...	...	...	...	30	...	...	...	...	...	...	...	19 3 3	For office record.
...	...	...	...	...	...	...	...	...	...	...	...	40 3 0	
...	...	...	...	...	...	...	...	...	...	...	...	2 2 6	For record in M. R. I. O.
...	...	...	...	...	...	...	...	...	...	...	...	1 11 6	Do.
...	...	...	...	...	...	...	...	...	...	...	...	129 9 6	
...	...	...	...	...	...	...	...	...	...	...	...	11 6 3	
...	...	...	...	...	...	...	...	...	...	...	...	62 6 3	
...	...	...	...	...	...	...	...	...	...	...	...	51 12 0	
...	...	...	...	...	...	...	...	...	...	...	...	41 8 3	
...	...	...	...	...	...	...	...	...	...	...	...	326 6 0	
...	...	...	...	...	...	...	...	...	...	...	...	175 7 0	* 2 transfers taken from old negatives.
...	...	...	...	...	...	...	...	...	...	...	...	4 11 6	
...	...	...	...	...	...	...	...	...	...	...	...	4 4 0	
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...	...	...	...	...	...	...	...	...	...	...	...	114 10 3	
...	...	...	...	1	...	...	...	...	...	...	...	60 0 0	
...	...	...	...	...	...	...	...	...	...	...	...	9 2 0	
...	...	...	...	...	...	...	...	...	...	...	...	2 8 0	For record in M. R. I. O.
...	...	...	14	6	...	...	...	...	...	...	...	32 15 6	
...	...	...	...	...	...	...	...	...	...	...	...	6 1 9	
...	...	...	...	...	...	...	...	...	...	...	...	37 15 0	
...	...	...	...	...	...	...	...	...	...	...	...	2 8 3	For record in M. R. I. O.
...	...	...	...	4	...	...	...	...	...	...	...	40 13 0	50 copies reprinted.
...	...	...	...	938	...	1	1	...	...	...	...	1,390 0 3	
...	...	...	...	...	...	...	...	...	...	...	...	8 9 0	
...	...	...	...	...	...	...	...	...	...	...	...	417 10 0	
...	...	...	...	...	...	...	...	...	...	...	...	22 14 0	
...	...	...	...	...	...	...	...	...	...	...	...	55 12 0	
...	...	...	...	...	...	...	...	...	...	...	...	10 12 0	Not yet printed.

Statement of Departmental Work done

Specification of Plate or Print.	Sheets or subjects in hand.	Nature of work.	Scale of Map. Original.	Scale of Map. Reproduced.	Size.	Negatives and transparencies.	Photo-zincographic and Lithographic Printing. Photo-transfer Prints.	Zinc plates transferred.	Zinc plates printed.	Stones.	Pulls.	Number of copies. Colored.	Uncolored.	Total.
Miscellaneous Maps and Plans —*contd.*			In. M.	In. M										
Scale for 24-mile map of Simla	1	Litho.	...	...	...	...	...	..	...	1	150	...	150	150
Sketch showing the position of the British Force at Lucknow under the command of His Excellency General Sir C. Campbell, G. C. B.	1	Do.	...	...	Atlas	...	...	...	...	1	30	...	30	30
Specimen and Sizes of symbols, letters and figures for Trans-frontier Sheets	1	Do.	...	...	½ Impl.	...	...	...	...	1	25	...	25	25
Star chart	3	Photo-zinco	...	...	...	2	2	1	1	...	150	...	150	150
Symbols and Abbreviations	1	Litho.	...	...	½ Impl.	...	...	...	...	1	30	...	30	30
Tide Tables for Rangoon River and Elephant Point	1	Photo-zinco	...	...	...	4	4	4	4	...	600	...	600	600
Tide Tables for the Port of Karachi	1	Do.	...	...	...	2	2	1	1	...	100	...	100	100
Tide Tables for Bombay for 1889	1	Do.	...	...	...	2	2	1	1	...	200	...	200	200
Ditto ditto Diagram for	1	Litho.	...	...	½ Impl.	...	...	...	...	1	200	...	200	200
Titles of Burma sheets	...	Photo-zinco	...	...	...	...	...	2	2	...	163	...	163	163
Trans-Salwin Shan State of Kian Tung	1	Do.	1=16	⅛	...	1	...	...	...	...	...	...	...	...
Trans-frontier sheets—														
N. E. Trans-frontier sheet No. 22 N. W. and S. W.	2	Blue print	1=4	¼	...	2	...	...	...	...	...	...	...	...
N. W. Trans-frontier one sheet	...	Photo-zinco	...	1=16	...	...	...	...	1	...	200	...	200	200
S. E. Trans-frontier sheets Nos. 1 N. E., S. E., 4 N. W., 15 S. E., 23 N. W., S. W.	7	Do.	1=4	½ & ¼	...	7	...	...	...	...	...	...	...	...
Unanda Pagan, Upper Burma	3	Silver prints	...	...	...	3	...	...	...	...	...	...	...	...
Experimental and Miscellaneous work—														
Heliogravure	5	...	...	...	...	24	1	...	...	...	...	...	...	...
Collotype	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Miscellaneous	6	...	...	...	...	6	6	4	2	...	350	...	350	350
Making Tracing Prints	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total	381	...	...	...	...	423	119	48	47	31	12,629	1,100	12,399	13,499
Departmental Forms	18	...	...	...	...	...	...	...	...	17	44,750	...	43,150	43,150
Work done in Type-Printing Section—														
Circular Orders	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Forms, &c.	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Memoranda, &c.	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Rubber Stamps	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Transfers and Proofs from Letter Press	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Abstract of Departmental Maps.														
Atlas sheets	5	...	...	...	...	...	...	...	...	5	340	...	340	340
General maps	58	...	...	...	...	55	64	45	26	11	4,844	450	3,044	3,494
Provincial maps	26	...	...	...	...	11	11	5	7	22	3,031	...	3,031	3,031
Divisional maps	4	...	...	...	...	16	16	4	5	...	550	...	550	550
District Maps	46	...	...	...	...	65	65	19	12	11	3,860	...	3,860	3,860
Plans of Cities and Cantonments	48	...	...	...	...	68	68	13	26	5	2,275	100	2,025	2,125
Standard Sheets	287	...	...	...	...	547	567	139	131	7	18,512	...	18,512	18,512
Index Maps	67	...	...	...	...	47	52	54	53	20	25,145	1,420	19,430	20,850
Technical Charts	19	...	...	...	...	32	32	10	2	...	50	...	50	50
Miscellaneous Maps and Plans	381	...	...	...	...	423	119	48	47	31	12,629	1,100	12,399	13,499
Departmental Forms	18	...	...	...	...	...	...	...	...	17	44,750	...	43,150	43,150
Transfers and proofs	...	...	...	...	...	...	...	...	...	...	1,739	...	...	...
Work done in Type Printing Section	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total	959	...	...	...	...	1,264	994	337	309	129	117,725	3,070	106,391	109,461
Cadastral Maps.														
North-West Provinces—														
Photo-zincographs	1,847	...	...	...	...	1,847	1,834	1,896	1,896	...	35,409	...	35,409	35,409
Zincographs	484	...	...	...	...	...	...	484	484	...	8,628	...	8,628	8,628
Total	2,331	...	...	...	...	1,847	1,834	2,380	2,380	...	44,037	...	44,037	44,037
Burma—														
Photo-zincographs	656	...	...	...	...	656	672	662	662	...	24,268	...	24,268	24,268
Zincographs	125	...	...	...	...	...	...	125	125	...	4,250	...	4,250	4,250
Total	781	...	...	...	...	656	672	787	787	...	28,518	...	28,518	28,518
Assam—														
Photo-zincographs	316	...	...	...	...	316	315	316	316	...	16,748	...	16,748	16,748
Zincographs	123	...	...	...	...	...	...	123	123	...	6,519	...	6,519	6,519
Total	439	...	...	...	...	316	315	439	439	...	23,267	...	23,267	23,267
Bengal—														
Photo-zincographs	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Zincographs	36	...	...	...	...	...	...	36	36	...	468	...	468	468
Total	36	...	...	...	...	...	...	36	36	...	468	...	468	468
Transfers and Proofs	...	...	...	...	...	...	...	...	...	...	7,592	...	...	...
TOTAL	3,587	...	...	...	...	2,819	2,821	3,642	3,642	...	103,882	...	96,290	96,290

GRAPHIC OFFICE.

during the year 1888-89—continued.

Type Printing.			Silver and other Printing.			Heliogravure and Electrotyping.				Photo-collotype.		Value.	Remarks.
Pages or items.	Pulls.	Copies.	Silver prints.	Blue prints.	Miscellaneous prints.	Plates.	Prints.	Photo. blocks.	Electrotypes.	Plates.	Prints.		
												R a. p.	
...	...	...	...	...	...	...	...	...	...	...	...	5 1 0	
...	...	...	...	...	...	...	...	...	...	...	...	49 7 0	
...	...	...	...	...	...	...	...	...	...	...	...	4 8 0	
...	...	...	...	...	...	...	...	...	...	...	...	71 8 6	
...	...	...	...	...	...	...	...	...	...	...	...	25 3 0	
...	...	...	...	...	...	...	...	...	...	...	...	132 3 6	
...	...	...	...	...	...	...	...	...	...	...	...	56 14 3	
...	...	...	...	...	...	...	...	...	...	...	...	66 12 0	
...	...	...	...	...	...	...	...	...	...	...	...	40 5 0	Includes binding charge, Rio.
...	...	...	...	...	...	...	...	...	...	...	...	31 4 3	
...	...	...	...	2	...	...	...	...	...	...	...	8 13 6	
...	...	...	...	8	...	...	...	...	...	...	...	22 8 0	
...	...	...	...	...	...	...	...	...	...	...	...	47 4 3	
...	...	...	...	28	...	...	...	...	...	...	...	63 0 0	
...	...	...	6	...	...	...	...	...	...	...	...	28 5 6	
...	...	...	15	2	...	7	42	...	...	...	...	425 14 0	
...	...	...	...	...	...	...	...	...	...	1	...	7 3 3	
...	...	...	...	2	...	...	...	...	...	...	...	174 14 9	
...	...	...	...	...	...	...	...	...	...	...	...	66 2 0	
...	...	...	155	1,038	...	16	490	...	9	1	...	7,432 9 0	
...	...	...	...	...	...	...	...	...	...	...	...	8,935 2 0	
28	4,050	3,600	...	...	...	...	...	...	...	...	...	146 15 0	
735	1,017,797	378,936	...	...	...	...	...	...	...	...	...	12,745 15 0	
482	127,743	124,136	...	...	...	...	...	...	...	...	...	1,580 11 0	
5	...	...	...	...	...	...	...	...	...	...	...	25 0 0	
5,396	27,585	27,585	...	...	...	...	...	...	...	...	...	2,911 4 0	
6,646	1,177,175	534,257	...	...	...	...	...	...	...	...	...	17,409 13 0	
...	...	...	...	...	...	...	...	...	...	...	...	64 9 0	
...	...	...	...	...	...	...	...	...	...	...	...	3,370 4 0	
...	...	...	...	4	...	...	...	...	...	...	...	1,325 3 6	
...	...	...	...	...	...	...	...	...	...	...	...	365 6 9	
...	...	...	...	...	...	...	...	...	...	...	...	2,909 7 9	
...	...	...	...	...	...	...	...	...	...	...	...	1,443 6 9	
...	...	...	...	5	...	...	...	...	...	...	...	16,290 14 0	
...	...	...	...	...	...	...	...	...	...	...	...	2,474 11 0	
...	...	...	...	...	...	...	...	...	...	...	...	401 4 0	
...	...	...	155	1,038	...	16	490	...	9	1	...	7,432 9 0	
...	...	...	...	...	...	...	...	...	...	...	...	8,935 2 0	
...	...	...	...	...	...	...	...	...	...	...	...	...	
6,646	1,177,175	534,257	...	...	...	...	...	...	...	...	...	17,409 13 0	
6,646	1,177,175	534,257	155	1,047	...	16	490	...	9	1	...	62,422 10 9	
...	...	...	...	...	...	...	...	...	...	...	...	27,962 9 0	
...	...	...	...	...	...	...	...	...	...	...	...	4,593 10 9	
...	...	...	...	...	...	...	...	...	...	...	...	32,556 3 9	
...	...	...	...	...	...	...	...	...	...	...	...	10,377 13 9	
...	...	...	...	...	...	...	...	...	...	...	...	1,353 14 3	
...	...	...	...	...	...	...	...	...	...	...	...	11,731 12 0	
...	...	...	...	...	...	...	...	...	...	...	...	6,402 6 6	
...	...	...	...	...	...	...	...	...	...	...	...	1,663 14 0	
...	...	...	...	...	...	...	...	...	...	...	...	8,066 4 6	
...	...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	175 8 0	
...	...	...	...	...	...	...	...	...	...	...	...	175 8 0	
...	...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	52,529 12 3	

PHOTOGRAPHIC AND LITHO

Statement of work done for other

SPECIFICATION OF PLATE OR PRINT.	Sheets or Subjects in hand.	Negatives and transparencies.	PHOTO-ZINCOGRAPHIC AND LITHOGRAPHIC PRINTING.							
			Photo-transfer Prints.	Zinc Plates transferred.	Zinc Plates printed.	Stones.	Pulls.	Number of Copies.		
								Colored.	Uncolored.	Total.
Adjutant General in India	3	...	...	...	1	1	80	...	100	100
Agent and Chief Engineer, B. C. Railway	...	...	...	...	1	...	25	...	25	25
Archæological Survey of India	38	46	28	4	5	22	18,620	...	19,325	19,325
Asiatic Society, Bengal	50	12	...	...	...	1	710	...	4,260	4,260
Board of Revenue, Bengal	16	...	...	6	6	14	5,300	2,200	5,600	7,800
Do. do. North-Western Provinces	...	...	...	...	2	...	400	...	400	400
Calcutta Municipality	9	3	3	2	2	4	2,400	...	3,400	3,400
Calcutta Volunteers	1	1	1	1	1	...	150	...	150	150
Central Provinces Administration	1	...	...	...	...	1	1,000	...	1,000	1,000
Do. do. P. W. D	1	...	...	...	...	1	30	...	30	30
Do. do. Settlement and Agricultural Department	1	...	...	...	...	1	1,000	...	1,000	1,000
Chemical Examiner to Government, Bengal	13	3	3	...	...	2	352	...	1,760	1,760
Chief Commissioner, Assam	1	...	1	...	...	1	8,100	...	8,100	8,100
Do. do. Burma	5	6	6	4	1	2	794	385	24	409
Do. do. Central Provinces	1	1	1	1	1	...	275	...	275	275
Chief Engineer Bengal, P. W. D.	24	88	88	26	29	...	1,980	...	2,060	2,060
Do. Mogulserai-Howrah Railway Survey	1	...	...	...	...	1	50	...	50	50
Commissary General-in-Chief	8	2	...	...	...	5	5,109	...	5,109	5,109
Commissioner of Chota Nagpur	...	...	...	4	...	...	...	...	...	...
Commissioner of Excise, Punjab	7	...	...	...	...	8	1,760	1,540	...	1,540
Commissioner of Police, Calcutta	5	...	...	...	...	6	3,600	2,550	...	2,550
Conservator of Forests, Madras	1	4	4	2	2	...	100	...	100	100
Do. School Circle, N.-W. P. and Oudh	1	...	...	...	...	1	130	...	130	130
Consulting Engineer, Government of India for Railways	4	...	...	...	...	2	157	...	261	261
Director General of Railways	3	...	...	...	...	2	110	...	110	110
Director General of Telegraphs	61	59	59	22	2	17	5,375	...	11,980	11,980
Director General of Post Offices, India	3	...	...	...	...	...	...	...	...	...
Director, North-Western Railway	8	4	7	2	2	2	1,315	...	4,415	4,415
Director, Geological Survey of India	8	6	...	...	...	5	3,050	...	3,460	3,460
Director of Land Records and Agriculture, Bengal	14	17	17	5	4	1	1,600	...	1,900	1,900
Do. do. Assam	1	...	...	...	...	1	200	...	200	200
Do. do. Lower Burma	1	...	...	...	...	1	100	...	100	100
Director of Public Instruction, Bengal	4	...	...	...	...	2	1,110	2,220	...	2,220
Director of Military Education in India	7	...	...	...	...	12	4,900	2,600	...	2,600
District Staff Officer, Meerut	8	8	8	2	2	...	100	...	100	100
Do. do. Peshawar	1	4	4	1	1	...	150	...	150	150
Deputy Commissioner, Bilaspur	1	...	...	...	...	1	500	...	500	500
Do. do. Mandalay	81	114	114	110	93	...	2,840	...	2,840	2,840
Deputy Assistant Quarter Master General, Mandalay	1	2	2	1	2	...	250	...	250	250
Executive Engineer, Secunderabad Division	...	...	...	16	20	...	4,000	...	800	800
Do. do. 1st Calcutta Division	2	4	4	2	2	...	100	...	100	100
Engineer in Chief, Bikanir railway Survey	...	...	...	1	1	...	110	...	110	110
Financial Commissioner, Burma	1	12	12	6	...	...	...	...	...	...
General Superintendent, Horse Breeding Department India	2	...	...	...	...	3	465	155	...	155
General Officer Commanding Quetta District	2	6	6	2	2	...	100	...	100	100
Do. do. Hyderabad Contingent	...	...	...	...	2	...	220	...	220	220
Government of India, Public Works Department	90	92	93	36	66	28	38,719	220	87,103	87,323
Do. do. R. and A. Department	13	7	11	...	...	3	1,084	...	1,171	1,171
Do. do. Foreign Department	18	8	8	3	2	10	1,151	...	1,233	1,233
Do. do. Military Department	30	7	8	5	5	11	4,244	200	4,178	4,378
Do. do. Financial Department	1	...	...	...	...	1	30	...	30	30
Government of Bengal, Revenue Department	61	1	1	3	1	57	36,042	30,418	2,725	33,143
Government of Bengal, Public Works Department	28	50	50	33	5	12	6,551	1,921	2,092	4,013
Do. North-Western Provinces, and Oudh	22	20	20	11	...	...	...	...	...	...
Do. Punjab, Revenue Department	15	50	50	10	14	1	1,405	...	1,405	1,405
Do. do. Public Works Department	12	15	15	14	8	2	3,175	...	5,750	5,750
Do. do. Financial Department	7	...	...	...	...	4	980	755	...	755
Inspector General of Military Works	8	18	19	8	11	...	5,920	...	13,270	13,270
Do. do. Artillery, India	3	...	...	...	...	1	300	...	900	900
Do. do. Jails, Bengal	8	...	...	...	...	3	1,500	...	4,000	4,000
Indian Museum	...	...	...	...	...	...	...	...	...	...
Master of the Mint, Calcutta	2	...	...	...	...	1	100	...	200	200
Meteorological Reporter, India	47	2	...	...	...	20	97,430	...	108,170	108,170
Do. do., Bengal	5	...	...	...	...	5	42,677	16	42,653	42,669
Port Commissioners, Calcutta	3	5	5	3	3	...	185	...	185	185
Port Officer and Registrar of Wrecks, Calcutta	2	...	...	...	...	4	515	130	125	255
Private Secretary to the Viceroy	1	1	...	...	...	...	...	...	...	...
Protector of Emigrants, Calcutta	9	...	...	...	...	10	2,720	2,445	...	2,445
Post Master General, Oudh	2	4	4	...	...	1	215	...	215	215
Do. do., North-Western Provinces	...	...	...	2	...	...	...	...	...	...
Do. do., Central Provinces and Berar	1	...	...	...	...	1	155	...	155	155
Quarter Master General in India	107	20	18	9	12	20	5,096	...	6,878	6,878
Sanitary Commissioners Assam	...	...	...	1	2	...	500	...	250	250
Do, do. Bengal	21	...	...	...	...	17	6,131	3,108	3,184	6,292
Do. do. Hyderabad Assigned Districts	1	...	...	...	...	1	205	...	205	205
Do. do. India	26	3	...	...	...	5	2,308	...	9,740	9,740
Secretary for Berar to the Resident at Hyderabad	2	1	1	1	...	1	390	...	390	390
Secretary, Mobilization Committee	8	...	...	...	...	2	200	...	800	800
Secretary to the Countess of Dufferin's Fund	3	...	...	...	...	...	...	...	...	...
Superintending Engineer, Central Provinces	...	...	...	...	3	...	90	...	90	90
Superintendent, Botanical Garden	2	...	2	...	...	...	...	...	...	...
Do. Forest Surveys, India	...	...	14	...	...	...	...	...	...	...
Do. Presidency Jail	1	1	2	1	...	...	...	...	...	...
Do. of Works, Calcutta	...	...	...	5	5	...	250	...	450	540
Do. of Stationery, Calcutta	3	...	...	...	...	3	2,400	...	2,400	2,400
Do. Government Printing, India	1	...	...	...	...	1	14	...	14	14
Do. Foundry and Shell Factory, Cossipore	1	...	...	...	...	1	300	...	300	300
Do. Campbell Medical School, Calcutta	1	...	...	...	...	1	200	...	200	200
pecial work done for Trade and private individuals	29	6	9	5	13	11	6,458	...	8,042	8,042
TOTAL	994	713	698	370	334	358	348,357	50,863	388,997	439,860

GRAPHIC OFFICE.

Departments, &c., during the year 1888-89.

Type Printing.			Silver and other Printing.			Heliogravure & Electrotyping.				Photo-collotype.		Value.			Remarks.
Pages or items.	Pulls.	Copies.	Silver Prints.	Blue Prints.	Miscellaneous Prints.	Plates.	Prints.	Photo. Blocks.	Electrotypes.	Plates.	Prints.	£	a.	p.	
...	...	...	...	...	...	...	...	...	...	...	...	43	11	6	
...	...	...	...	...	...	...	...	...	...	...	...	2	12	3	
...	...	...	...	32	...	18	9,804	...	...	...	...	4,798	11	6	
...	...	...	...	8	...	2	1,383	...	3	3	826	1,185	6	9	30 subjects not yet printed.
...	...	...	...	...	...	...	...	...	...	...	...	1,068	5	0	6 do. do. do.
...	...	...	...	...	...	...	...	...	...	...	...	151	5	3	
...	...	...	...	...	...	...	...	...	...	...	...	349	3	0	
...	...	...	...	...	...	...	...	...	...	...	...	37	13	9	
...	...	...	...	...	...	...	...	...	...	...	...	240	13	0	
...	...	...	...	...	...	...	...	...	...	...	...	95	11	0	
...	...	...	...	...	...	...	...	...	...	...	...	240	13	0	
...	...	...	...	...	...	...	...	...	...	...	...	111	11	3	
...	...	...	...	...	...	...	...	...	...	...	...	210	10	6	
...	...	...	...	...	...	...	...	...	...	...	...	532	5	9	1 subject not yet printed.
...	...	...	...	...	...	...	...	...	...	...	...	44	4	0	
...	...	...	...	...	...	...	...	...	...	...	...	1,801	15	3	
...	...	...	...	...	...	...	...	...	...	...	...	12	0	0	
...	...	...	...	2	...	...	...	...	...	...	...	262	3	6	1 subject not yet printed.
...	...	...	...	...	...	...	...	...	...	...	...	57	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	226	11	0	
...	...	...	...	...	...	...	...	...	...	...	...	340	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	82	15	6	
...	...	...	...	...	...	...	...	...	...	...	...	30	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	165	9	0	
...	...	...	...	...	...	...	...	...	...	...	...	313	6	0	
...	...	...	...	...	...	...	...	...	...	...	...	2,266	15	9	10 subjects not yet printed.
...	...	...	...	...	...	...	...	...	...	...	...	198	0	0	Not yet printed.
...	...	...	...	...	...	...	...	...	...	...	...	355	14	0	
...	...	...	15	...	...	1	660	...	...	...	...	964	9	3	1 subject not yet printed.
...	...	...	...	...	...	...	...	...	...	...	...	402	4	3	
...	...	...	...	...	...	...	...	...	...	...	...	54	8	0	
...	...	...	...	...	...	...	...	...	...	...	...	19	5	0	
...	...	...	...	...	...	...	...	...	...	...	...	130	5	0	
...	...	...	...	...	...	...	...	...	...	...	...	936	5	0	
...	...	...	...	...	...	...	...	...	...	...	...	126	9	6	
...	...	...	...	...	...	...	...	...	...	...	...	91	9	0	
...	...	...	...	...	...	...	...	...	...	...	...	120	9	0	
...	...	...	...	...	...	...	...	...	...	...	...	2,819	14	0	
...	...	...	...	...	...	...	...	...	...	...	...	74	1	0	
...	...	...	...	...	...	...	...	...	...	...	...	534	11	6	
...	...	...	...	...	...	...	...	...	...	...	...	77	2	9	
...	...	...	...	...	...	...	...	...	...	...	...	19	5	6	
...	...	...	...	...	...	...	...	...	...	...	...	176	11	3	
...	...	...	...	...	...	...	...	...	...	...	...	174	7	0	1 subject not yet printed.
...	...	...	...	...	...	...	...	...	...	...	...	97	15	3	
...	...	...	...	...	...	...	...	...	...	...	...	49	6	6	
...	...	...	...	...	...	...	...	...	...	...	...	9,839	1	9	
...	...	...	...	2	...	6	6,809	...	...	...	...	1,707	9	0	
...	...	...	23	...	...	...	...	...	...	...	...	665	2	9	
...	...	...	...	...	...	...	...	...	...	...	...	532	7	9	
...	...	...	...	...	...	...	...	...	...	...	...	20	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	2,198	3	3	
...	...	...	...	...	...	...	...	...	...	...	...	1,720	3	6	
...	...	...	...	...	...	...	...	...	...	...	...	671	7	3	Not yet printed.
...	...	...	...	...	...	...	...	...	...	...	...	1,086	5	9	
...	...	...	...	...	...	...	...	...	...	...	...	930	11	3	1 subject not yet printed.
...	...	...	...	...	...	...	...	...	...	...	...	247	10	0	4 do. do. dc.
...	...	...	...	...	...	...	...	...	...	...	...	1,221	4	0	
...	...	...	...	...	...	...	...	...	...	...	...	78	13	0	
...	...	...	...	...	...	...	...	...	...	...	...	252	15	0	
...	...	...	184	...	...	1	1	...	...	...	...	130	12	9	
...	...	...	...	...	...	...	...	...	...	...	...	31	9	0	R10 charged for finishing a medallion.
...	...	...	...	...	...	2	3	...	...	...	...	3,094	4	3	3 subjects not yet printed.
...	...	...	...	...	...	...	...	...	...	...	...	606	8	0	
...	...	...	...	...	...	...	...	...	...	...	...	111	12	6	
...	...	...	...	...	...	...	...	...	...	...	...	150	3	0	
...	...	...	2	...	...	...	...	...	...	...	...	3	9	6	
...	...	...	...	...	...	...	...	...	...	...	...	291	3	0	
...	...	...	...	...	...	...	...	...	...	...	...	276	1	3	
...	...	...	...	...	...	...	...	...	...	...	...	10	12	9	
...	...	...	...	...	...	...	...	...	...	...	...	230	5	0	
...	...	...	...	4	...	...	...	...	...	...	...	3,328	2	6	
...	...	...	...	...	...	...	...	...	...	...	...	69	5	3	
...	...	...	...	...	...	...	...	...	...	...	...	598	15	0	
...	...	...	...	...	...	...	...	...	...	...	...	62	6	0	
...	...	...	8	...	...	1	...	...	...	...	...	423	6	9	
...	...	...	...	...	...	...	...	...	...	...	...	68	5	6	
...	...	...	...	...	...	...	...	...	...	...	...	110	15	0	
...	...	...	2	...	...	2	1,155	...	...	...	...	219	14	3	
...	...	...	...	...	...	...	...	...	...	...	...	23	7	6	
...	...	...	...	...	...	1	2	...	...	...	...	100	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	74	6	3	
...	...	...	...	...	...	...	...	...	...	...	...	14	12	9	
...	...	...	...	...	...	...	...	...	...	...	...	71	4	6	
...	...	...	...	...	...	...	...	...	...	...	...	235	8	0	
...	...	...	...	...	...	...	...	...	...	...	...	2	6	0	
...	...	...	...	...	...	...	...	...	...	...	...	49	4	0	
...	...	...	...	...	...	...	...	...	...	...	...	13	3	0	
...	...	...	...	1	...	...	...	...	...	...	...	882	10	6	
...	...	...	234	49	...	34	19,817	...	3	3	826	54,553	2	3	

MATHEMATICAL INSTRUMENT OFFICE.

TABLE A.

Detail of issues to and receipts from Provinces and Departments, during the financial year 1888-89.

Provinces and Departments.	Receipts. Value.	Issues. Value.	Debits. Value.	Credits. Value.
	₹	₹	₹	₹
Archæological Survey	...	494	494	...
Assam	569	2,257	1,688	...
Bengal, Civil	12,587	43,979	31,392	...
„ Military	6,523	14,444	7,921	...
Bombay, Civil	26	741	715	...
„ Military	5,003	2,507	...	2,496
Burma	412	16,811	16,399	...
Central Provinces	486	5,868	5,382	...
Berar	...	133	133	...
Forests	...	1,696	1,696	...
General Administration, P. W. D.	...	24	24	...
Geological Survey and Museums	2	247	245	...
Guaranteed Railways, E. I. Railway	...	99	99	...
„ „ Bombay, Rajputana-Malwa Railway	...	44	44	...
Hyderabad, P. W. Department	...	10	10	...
Law and Justice, Port Blair and Nicobars	...	34	34	...
Madras, Civil	...	13,797	13,797	...
„ Military	4,319	4,100	...	219
Marine	438	1,052	614	...
Meteorological Department	2,108	1,206	...	902
Mint	491	8	...	483
N.-W. P. and Oudh	299	1,793	1,494	...
N. W. State Railway, P. W. Department	8,982	2,983	...	5,999
P. W. D., Military Works	4,843	3,836	...	1,007
P. W. D., Coorg	3	164	161	...
Punjab	1,539	6,248	4,709	...
Rajputana and Central India, P. W. D.	788	288	...	500
Sind-Pishin-Bolan State Railway	1,876	676	...	1,200
Survey Department	17,176	83,456	66,280	...
Telegraph	210	282	72	...
TOTALS	68,680	2,09,277	1,53,403	12,806
NET DEBIT	...	...	1,40,597	
Cash Sales	...	9,807	9,807	
GRAND TOTALS	68,680	2,19,084	1,50,404	

MATHEMATICAL INSTRUMENT OFFICE.

TABLE B.

Instruments, &c., purchased in the local market during the financial year 1888-89.

Instruments.	Number.	Value. ₹	a.
Alt-azimuth pocket Instruments	12	963	12
Barometers, Aneroid, small	13	888	8
Boards, drawing, cavalry pattern	24	406	4
Cartometers	6	45	0
Cases, sketching, leather	3	31	1
Clinometers	10	382	3
Compasses, beam, with adjustment 2′	2	72	0
„ bow, sets	6	36	12
„ drawing, common, brass, 5″	550	687	8
„ „ „ „ 6″	250	375	0
„ „ „ electrum, 5″	200	350	0
„ „ „ „ 6″	50	100	0
„ „ hair, electrum, 5″	12	60	12
„ magnetic, for planetables, 2½″	36	216	0
„ „ pocket, in electrum cases	12	108	0
„ prismatic, S. R., 4″	16	1,330	0
„ „ „ 6″	3	343	8
„ „ „ 4½″	12	1,104	0
„ „ Hunter's and Huchison's	17	449	4
„ proportional, brass, 6″	6	87	0
„ subtense	1	450	0
Curves, railway, large and small sets	8	377	14
Curve ranger attachment, for 6″ transit theodolites	1	216	4
Glasses, binocular, large	16	839	0
„ „ small	23	857	8
„ copying or tracing	35	427	12
Horizons, mercurial	13	1,014	12
Hydrometers with glass floats	12	420	0
Instruments, drawing mathematical, brass, 1st sort	27	1,871	4
„ „ „ „ 2nd „	12	478	2
„ „ „ electrum, 1st „	9	703	0
„ „ „ „ 2nd „	4	196	13
Lamps, bull's-eye	9	36	0
„ mining	6	45	12
Lenses, reading, ½″ and 1″	24	19	8
„ „ 2″	16	39	0
„ „ 3″ and 3½″	6	19	8
„ „ 4″	6	24	6
Levels, engineering, 9″	4	460	0
„ reflecting, Abney's	10	378	2
Machines, map-printing, Ordnance pattern	12	510	0
Magnets, horse-shoe, 6″	1	1	6
Pens, drawing common, ivory handles	181	334	12
„ double or road	7	36	11
Pentagraph, English, 2½″	1	153	0
Planimeters, brass	2	99	0
„ electrum	9	415	12
Protractors, plain, circular, brass, 6″	6	170	4
„ „ „ „ 9″	6	255	6
„ „ „ „ 12″	4	227	0
„ rectangular, ivory, 6″	12	39	0
„ „ „ (military)	24	73	8
„ „ wooden, 6″	43	74	0
Pins for chains, common pattern	2,000	156	4
„ „ Revenue Survey pattern	500	93	12
Rules, carpenter's, boxwood, 2′, 4-fold	14	13	14
„ flat, ebonite, 6″	150	70	5
„ „ „ 1′	100	75	0
Carried over	4,554	19,709	15

MATHEMATICAL INSTRUMENT OFFICE.

TABLE B—*continued.*

Instruments, &c., purchased in the local market—continued.

	Number.	Value.
Instruments—continued.		₹ a.
Brought forward	4,554	19,709 15
Rules, parallel, bar, ivory	12	28 8
„ „ „ wooden, 6″	12	9 0
„ „ on rollers, brass, 18″	3	77 0
„ „ „ „ 2′	4	133 0
„ „ „ electrum, 12″ (Capt. Field's pattern)	2	108 0
„ „ „ wooden, 12″	11	105 13
„ sight, for plane-tables	250	750 0
Scales, architect, boxwood, single	72	207 0
„ diagonal, metal	106	547 8
„ engine divided, cardboard, single	2	2 0
„ Marquois sets, wooden	4	28 0
„ offsets, single „	75	47 10
„ plotting, sets „	1	12 10
„ „ single „	68	195 10
Sheets, horn	200	106 4
Slopes and batters, ebonite, single	24	19 8
Squares, optical	450	2,925 0
„ set, ebonite sets	17	170 0
„ „ „ single	78	101 1
Sun-dials	2	40 0
Stands for compass, prismatic	31	544 0
„ „ levels, dumpy	4	140 0
„ „ plane-tables	356	2,570 0
„ „ theodolites	4	300 0
„ „ subtense compasses	1	54 0
T squares, wooden	9	38 4
Tapes, measuring, 50′ metallic and linen	28	105 7
„ „ 100′ „ „ „	52	347 8
„ „ 66′ steel	5	137 8
„ „ 100′ „	6	138 0
Telescopes, with pancratic eyepiece, terrestrial	10	815 8
Theodolites, without vertical circle, transit, 6″	4	2,000 0
Thermometers, chemical or traveller's	4	22 0
„ common	22	142 0
TOTALS	6,483	32,677 10
Books.		
Abercrombie's Weather	1	3 5
Cooley's Cyclopœdia of Practical Receipts	2	27 15
Hints to Travellers	3	15 0
Loomis' Treatise on Astronomy	1	7 0
Manual of Wheeler's Series—Graham's Brass Founders	1	1 6
Nautical Almanacs	112	218 12
Goodeve's Principle of Mechanics	1	4 0
Tables for Barometrical Heights by Mackesy	3	5 15
„ Log., Chambers'	41	112 6
„ „ Hutton's	21	167 0
„ Traverse, Boileau's	19	148 1
TOTALS	205	710 12
Sundries.		
Boxes for tracing glasses	1	2 0
Cases, leather	90	385 0
Coddington's Lens, 1″	1	7 0
Glasses for pluviometers	50	200 0
Carried over	142	594 0

MATHEMATICAL INSTRUMENT OFFICE.

TABLE B—*continued.*

Instruments, &c., purchased in the local market—concluded.

	Number.	Value.
Sundries—continued.		₹ a.
Brought forward	142	594 0
Glasses, test, for hydrometers	16	24 0
„ ink bottles	36	5 3
„ for mining lamps	12	3 12
Gauges „ „	6	6 0
Hexagon nut angles	12	12 0
Numbers for chain iron, sets	2,400	675 0
Horn centres	12	1 14
Stencil plates	201	174 14
Telescopes for Watkins' Range Finders	12	91 8
Tripod stand for mining lamps with jointed legs and caps	2	76 0
Trunks, mule, leather	12	174 0
Umbrellas, surveying	12	192 0
Washers, Asbestos, for mining lamps	2	1 0
Wicks, for mining lamps	lb. 1	2 12
Elastic Bands	24	2 12
Squares, steel, American	3	30 6
Electric bell	1	22 8
Show-case	1	17 0
Electric light, &c.	1	47 8
Knife, spatulas	4	2 12
Book of stars	1	4 0
Purified oxgall	1	2 8
Battery cells	6	13 8
Crow-quills, steel	doz. 3	4 1
Oven thermometer	1	46 0
TOTALS, SUNDRIES	2,924	2,226 14
„ BOOKS	205	710 12
„ INSTRUMENTS	6,483	32,677 10
GRAND TOTALS	9,612	35,615 4

TABLE C.

List of instruments, &c., manufactured in workshop during the financial year 1888-89.

	Number.	Value.
Instruments.		₹ a.
Bars, standard, steel	3	130 0
Boards, drawing, deal, large	75	1,242 0
„ „ cavalry pattern	4	57 8
„ „ deal, small	4	17 6
„ „ teak, large	5	68 0
Chains, iron, measuring, 30′ and 33′	352	1,599 8
„ „ „ 66′	950	8,075 0
„ crinoline steel	2	32 0
„ other sizes and sorts	10	110 0
Clinometers, with hill shading scale and plummet	48	72 0
„ survey pattern	112	3,420 0
Combs, acre calculating, card board	1,874	646. 7½
Compasses, magnetic, for plane-tables, 5″	50	675 0
Carried over	3,489	16,144 13½

MATHEMATICAL INSTRUMENT OFFICE.

TABLE C—*continued.*

List of instruments, &c., manufactured in workshop, &c.—continued.

	Number.	Value.	
		₹	a.
Instruments—continued.			
Brought forward	3,489	16,144	13½
Glasses, copying or tracing	19	957	8
Heliographs	3	360	0
Hold-alls	34	488	0
Lamps, referring	12	60	0
Levels, field service, 4′	18	510	0
„ water	12	34	0
Plane-tables, deal	532	4,643	8
„ „ military pattern	21	84	0
„ teak	4	41	8
Pluviometers, Symon's pattern	110	920	0
Protractors, circular, card board, 12″	140	32	8
Pins for chains, common pattern	1,000	78	2
Rods, measuring, wooden	142	365	8
Rules, flat, ebonite, 6″	15	5	10
„ „ „ 1′	31	23	4
„ „ wooden, 1′	238	101	10
„ parallel on rollers, electrum, 6″	6	60	0
„ sight for plane-tables	6	83	0
„ „ „ military pattern plane-tables	29	290	0
Scales, architect, boxwood, sets	1	12	0
„ Bengali, card board	200	12	8
„ diagonal, card board	695	153	4
„ „ metal	39	303	0
„ engine-divided, card board, single	2,166	541	8
„ offsets, single, card board	135	3	2
„ „ „ ivory	275	114	6
„ plotting, sets, wooden	9	119	0
„ „ single, metal	1	10	0
Slopes and batters, ebonite, single	2	1	12
Squares, set ebonite, sets	22	141	0
Staves, cross or offsets	12	60	0
„ for omnimeters	12	300	0
„ „ subtense theodolites and compasses	10	180	0
„ levelling, Roorkee pattern, double	12	288	0
„ „ telescopic, Sopwith's	50	800	0
Stamps for conventional signs	8	24	0
Stands for plane-tables	142	1,384	8
„ „ theodolites	2	120	0
„ „ sun thermometers	12	96	0
„ „ barometers	2	90	0
„ „ heliographs	3	60	0
Telescope, common	1	7	0
TOTALS	9,672	30 108	15½
Sundries.			
Boxes of sorts	78	71	6
„ deal-wood	2	5	8
Cases, packing	647	1,479	11
„ leather	2	6	0
Canvas bags, water-proof, lined	14	94	0
Doolies	12	17	4
Havresacks	4	6	0
Ink rollers, small	6	15	0
Plummets, brass	12	15	0
Stencil plates	78	120	0
Carried over	855	1,829	13

MATHEMATICAL INSTRUMENT OFFICE.

TABLE C—*concluded.*

List of instruments, &c., manufactured in workshop, &c.,—concluded.

	Number.	Value.	
		₹	a.
Sundries—continued.			
Brought forward	855	1,829	13
Scales, ivory	1	2	8
Squares, acre, horn	25	18	12
Tubes, tin	80	66	5
Traverse indicator	6	3	0
Thermometer cage	1	15	0
Tracing tables	3	60	0
Acre squares	150	112	8
Handles for chains	10	9	0
Levels, spirit	1	3	8
Chains, iron, 10 links	2	4	0
Badges, brass	48	144	0
Instrument for chain measurement	1	8	0
Straps for badges	6	12	0
Screws, brass, clamping	2	5	0
Printing frames	3	110	0
Talc squares	212	36	8
Bubble tester box	1	10	0
Collimator for adjusting instruments	1	266	0
Rings for chains	100	2	8
Tin pots	3	0	6
Newar straps for boxes	4	4	0
Rods for subtense theodolites	2	20	0
Stands for „ „	2	15	0
Markers' steel	3	4	0
Links, spare, for chains	20	0	8
Clamping screws	1	2	0
Stands for plane-tables	1	4	8
Gauges, horn	4	5	4
TOTALS, SUNDRIES	1,548	2,774	0
„ INSTRUMENTS	9,672	30,108	15½
TOTALS	11,220	32,882	15½
Brass Castings, &c., for Material Stock	...	1,959	0
GRAND TOTALS	...	34,841	15½

TABLE D.

List of principal instruments repaired in workshop during the financial year 1888-89.

	Number.
Anemometers	16
Anemographs	2
Arithmometer	1
Barometers of sorts	56
Camera	1
Chains of sorts	56
Chronographs of sorts	5
Chronometer	1
Chronomicrometer	1
Circumferenter	1
Clinometers	10
Clocks of sorts	5
Compasses, beam	2
„ boat	2
Carried over	159

MATHEMATICAL INSTRUMENT OFFICE.

TABLE D—*continued.*

List of principal instruments repaired in workshop, &c.—concluded.

	Number.
Brought forward . .	159
Compasses, bow pens	33
„ bow pencils	4
„ drawing, of sorts	117
„ magnetic, for plane-tables, &c.	41
„ magnetic, pocket, or watch pattern	20
„ Marine	1
„ prismatic, of sorts	76
„ proportional	3
„ surveying, of sorts	106
Cases of sorts	6
Ellipgraph	1
Glasses, binocular	114
„ tracing	40
Heliographs	5
Hydrometers	124
Hygrometer	1
Indicators, small (Richard's)	3
Instruments, drawing, mathematical, of sorts	39
Lamp, bull's-eye	1
„ referring	1
Lenses, of sorts	4
Levels, of sorts	96
„ of spirit	6
Meter, current	2
Microscopes	6
Pens, drawing, of sorts	196
Pentagraph	1
Perambulators	3
Pins for maps, of sorts	107
Pins for chains	40
Plane-table	1
Planimeters, of sorts	15
Pluviometers	3
Protractor	1
Quadrant, Gunner's	3
Range finders, of sorts	65
Rules, of sorts	40
Rules, sight, for plane-tables	7
Scales, of sorts	16
Sector, ivory	1
Sextants, of sorts	6
Squares, optical	144
Square, sets, ebonite	1
Stand for circumferenter	1
Stands for compasses, of sorts	47
„ „ heliograph	1
„ „ levels	52
„ „ plane-tables	2
„ „ range finders	10
„ „ telescope	1
„ „ theodolites	52
Staves, levelling, of sorts	63
T squares	2
Tapes, of sorts	367
Telescopes, of sorts	70
Theodolites, of sorts	89
Thermometers, of sorts	131
Trammelhead, for beam compass	1
Watches, of sorts	2
TOTAL OF PRINCIPAL INSTRUMENTS REPAIRED .	2,550
MINOR INSTRUMENTS REPAIRED .	636
TOTAL OF ALL INSTRUMENTS REPAIRED .	3,186

Profit and Loss Account of the Workshop for the financial year 1888-89.

Debits.	R	a.	Credits.	R	a.
Workshop establishment, less proportion debitable to the store branch for cleaning and adjusting serviceable instruments	37,544	3	By repairs for public officers	13,657	9
One-third of office establishment	2,329	13	„ „ Interdepartmentally	111	0
Pay of Material Store-keeper for the whole year	770	0	By repairs to stock	18,965	9
Workshop contingencies as distinguished from materials purchased	739	15	„ manufactures for stock—		
Value of materials—			Instruments	31,386	11
For special work	21,212	6	Packing cases	1,496	5
„ general workshop use			„ manufactures for materials	1,959	0
„ manufacture of packing cases					
Paid for repairs	54	0			
Wear and tear of plant	2,238	1	Work on prepayment	1,290	4
Half of rent at R325 per mensem from April to June 1888 and R600 from July to March 1889	3,187	8	Workshop loss	2,926	10
Printing and stationery	487	8			
Four per cent. on value of tools and plant amounting to R80,740	3,229	10			
Total	71,793	0	Total	71,793	0

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Extract from the Narrative Report of MR. W. H. COLE, M.A., *in charge Computing Party—season 1888-89.*

Up to February 23rd, 1889, Captain S. G. Burrard, R.E., held charge of five of the sections of this party, *viz.*, the Computing, Photozincography, Type-printing, Stores and Solar Photography. On that date he was relieved by me on return from furlough, but he continued to do duty in the office till 2nd May 1889, when he was posted to the charge of the Astronomical Parties. Colonel T. H. Holdich, R E., held charge of the Drawing section up to the 17th April 1889, except that, having to visit Quetta in March 1889, the charge devolved temporarily on me from the 11th of that month to the 8th April. On the 17th April Major St. G. C. Gore, R.E., took over the section and retained charge for the rest of the year. Since Captain S. G. Burrard's transfer there has been no assistant officer of the senior branch in the Computing party.

The following tabular statements exhibit the money value of the work performed by the Computing section during the Survey year 1888-89—

Statement of Expenditure (Dr.) and amounts credited (Cr.)

DR.	₹	₹	CR.	₹	₹
Deputy Superintendent's salary	11,669		Departmental work as shown in the following table	44,604	
Establishment	32,443				44,604
Contingencies and travelling allowances	347		Extra-departmental work done	240	
		44,459			240
Stores received from England	22				
		22			
Stationery	55				
		55			
Library, books and periodicals	308				
		308			
TOTAL	...	44,844	TOTAL	...	44,844

Statement of Departmental Work.

Class.	Value.
	₹
Records, Library (including cost of purchase of books, &c.)	1,383
Compu ations	15,521
Accounts, returns, correspondence	1,412
Supply of data, &c.	1,626
Preparation of press copy	8,550
Examination of press proofs	4,938
,, charts, &c.	567
Protection of stations	1,028
Miscellaneous	8,376
Meteorology and general science	1,203
TOTAL	44,604

Statement showing the value of work done for other Departments.

Department.	Value.
	₹
Meteorological Department	240
TOTAL	240

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Some explanations of the various items will now be given.

CLASS 1. RECORDS, LIBRARY, &C.—The records of all the Survey operations appertaining to the Trigonometrical Branch, from the time of Colonel Lambton to the present date, find a resting place in this office, where they are carefully stored and periodically inspected. As each instalment is received, it is closely examined, as to completeness in all required details, indexed, registered, and a detail receipt furnished to the Executive Officer from whom it comes; where incompleteness is observable, Executive Officers are at once called on to supply the details wanting. The custody of the Library, which now contains over 4,000 volumes and pamphlets of a scientific character, also comes under this head, as well as the cost of books and periodicals purchased during the year, both for the Library itself and also for the several Survey parties of the Trigonometrical Branch. During a previous year, the books of the Library were systematically classified and arranged by shelves: every volume was numbered and labelled, and the compilation of the Library Catalogue was finished, and the greater portion passed through the press. The publication has been completed during the year under report, and with the rules now in force, for the issue and return of books, &c., it is practically impossible for any volumes to go astray. A copy of the Catalogue will be sent to each field party.

CLASS 2. COMPUTATIONS.—

(*a*) *South-West Quadrilateral.*—The adjustment of the heights of the principal stations of the Kattywar Meridional Series has been completed, and that of the Guzerat Longitudinal Series has been partly done.

(*b*) *North-East Quadrilateral.*—Considerable progress has been made with the reduction of the secondary triangulation of the Assam Longitudinal Series. The North-East Longitudinal Series is still in abeyance pending the receipt of data from the Himalaya Party.

(*c*) *Southern Trigon.*—The adjustment of the heights of the principal stations of nearly the whole Trigon has been made and the reduction of Colonel Lambton's triangulation has been proceeded with, and considerable progress has been made with it; but the work is very extensive, and much remains to be done.

(*d*) *Principal Triangulation East of 92°.*—Computed 16 deductions of latitude, longitude and azimuth of the real and check traverse, and circumpolar azimuth at one station.

(*e*) The following assistance was rendered to Field Parties:—Two computers were lent for about 2 months to the Astronomical Parties for reduction of latitude observations, season 1888-89; one computer was occupied for about 1½ months in bringing up certain arrears of computations appertaining to the Coast Party; one computer for 1½ months in reducing the field work of the Hazara Field Force, and in bringing up certain computations of the Quetta Principal Series executed by Mr. McNair in the early part of the season 1888-89. Observations for time, latitude and heights were reduced for the Quarter Master General's Department.

(*f*) Certain tables of the electro-longitude operations, season 1885-86, were recomputed.

Spirit-levelled heights for Pamphlet No. 4, Madras Presidency, Madras to Vizagapatam, were adjusted; the remaining work performed under this head was of a miscellaneous character.

CLASS 3. ACCOUNTS, RETURNS AND CORRESPONDENCE.—Under this head are included indents, estimates, monthly detailed and abstract progress reports, stock returns of ordnance stores, the compilation of data for the Annual Report, and various other items. The assistance rendered in the current work of the Deputy Surveyor-General's Office is also included in this class.

CLASS 4. SUPPLY.—Requisitions from 14 officers for data of various kinds have been complied with. In this class is also included the cost and labour in the despatch of maps, charts, books, and forms.

CLASS 5. PREPARATION OF PRESS COPY.—This consists in the writing of the letterpress for the several publications; and also in abstracting and compiling the results of the several calculations in a suitable form for publication. All tabular data, when so compiled, are carefully compared twice before handing to the printer. The details of the work are as follows:—

(*a*) *Southern Trigon.*—The descriptions of the stations of the South Konkan Coast Series were revised and completed. The abstracts of heights of the Bombay Longitudinal, South Konkan Coast and Mangalore Meridional Series were completed, and those of the Madras Longitudinal and Madras Meridional and Coast Series nearly finished. Introductory chapters for the professional volumes stand ready for the press, of which No. I and part of No. II have been finally revised and completed. All the above appertains to the professional volumes. As regards the matter for the synoptical volumes, considerable progress has been made during the year in revising and compiling of details appertaining both to the secondary triangulation of the modern survey and that of Colonel Lambton's network, but this seems likely to prove a rather lengthy and heavy job yet.

(*b*) *South-West Quadrilateral.*—The introductory chapters or Part I of the professional volume of this Quadrilateral are nearly complete; the introductions to the six series

have been compiled, and with the exception of one of them, *viz.*, the Guzerat Longitudinal Series, have all been finally revised and completed. The abstract of heights of the Kattywar Meridional Series has been finally revised and completed. Some progress has also been made in compiling the observed azimuth, and in preparing the revised descriptions of the stations of the Singi Series. The secondary triangulation, the details of which are embodied in synoptical volumes, has not been touched yet.

(*c*) Letter-press for the Coast Series charts, Nos. 10, 11, 14, 15 and 16, has been revised and completed for the final publication.

(*d*) *Spirit-levelling Operations.*—The pamphlet of heights, No. 4, Madras Presidency, was revised and passed through the press.

(*e*) *Electro-telegraphic Longitude Operations.*—The Pen Equation table was revised and passed through the press.

(*f*) *Library Catalogue.*—This was completed and passed through the press.

(*g*) The list of charts of coast line triangulations was prepared and examined.

(*h*) *Hand-Book, Trigonometrical Branch.*—Taken in hand and some progress made.

In last year's report it was stated that, owing to the contemplated extension of the principal triangulation into Upper Burma, it has been decided to dissever the Assam Valley Triangulation from the North-East Quadrilateral, and to include it for simultaneous reduction with all the principal triangulation east of 92°. As, however, this work all stands ready for publication, and is likely to be wanted for local and geographical purposes before long, it has been thought advisable to publish it in a preliminary form, and this will be taken in hand at an early date.

CLASS 6. PRESS PROOFS.—The work done under this heading relates entirely to the Printing section. It consists of the examination and comparison of proofs. As most of the matter printed is numerical, or depends on numerical data, this examination can only be performed by men thoroughly acquainted with all the details of the subject in hand. Ordinary press readers could not be expected to render the critical examination which such matter requires. The charge for this class, though shown against the Computing section in order to balance the cost, is debited against the Printing section.

CLASS 7. CHARTS.—The careful examination of all charts of triangulation and spirit-levelled heights before publication is a matter of much importance, and this work is also performed by the Computing section, where the familiarity with the original records renders the detection of mistakes much easier and more certain than if the examination were made by the draftsmen themselves. The principal subjects examined were coast secondary triangulation charts Nos. 10, 11, 14, 15 and 16, of which a provisional publication had to be made; two charts of Afghan Boundary Triangulation, the chart to accompany the pamphlet of levels in Madras entitled "No. 4, Madras Presidency," and also several other items.

CLASS 8. STATIONS.—The necessary professional aid in connection with the protection of survey stations has been rendered by the Computing section to the Office of the Deputy Surveyor-General. During the year under review 684 stations have been repaired by District Officers at a cost of ₹2,315. Fifty-one districts out of 329, from which reports are due, failed to submit them.

CLASS 9. MISCELLANEOUS.—In this class are included several duties of the Computing section which cannot fairly be assigned to any of the other classes, such as the following:—

(*a*) The current observatory work at Dehra, the rating of the chronometers, the cleaning and keeping in order of instruments of the larger class, &c.; (*b*) the taking and reducing of time observations at Mussooree in order to give time for the 12 o'clock gun; (*c*) the examination and systematic storing of the special equipment; the determination of the micrometer scales of 9 subtense compasses and the level scales of 14 levels; (*d*) the preparation or revision of professional forms; (*e*) the instruction of Mr. McNair in taking circumpolar observations with 24-inch theodolite; the instruction of Colonel Sartorius, B.S.C., and Yusuf Sharif, K.B., in astronomical observations for time, latitude and azimuth; also that of Mr. Wainright in the use of the 18-inch theodolite and in taking circumpolar observations; (*f*) eight candidates were examined for the Junior Branch of the Department; (*g*) assistance rendered to the Deputy Surveyor-General on a variety of professional and official points.

CLASS 10. METEOROLOGY AND GENERAL SCIENCE.—

Meteorological Observations.—A complete set of meteorological observations was taken daily throughout the year at Dehra Dun, and monthly abstracts prepared. The results are given in the following statements:—

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Mean Monthly Readings of Earth Thermometers.

Depth in feet of thermometer bulbs below surface of ground.	Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
		°	°	°	°	°	°	°	°	°	°	°	°
25·6	1881	...	...	...	...	...	73·55	73·90	75·02	76·07	76·69	76·98	*76·71
	1882	75·91	75·13	74·52	74·11	73·97	74·05	74·31	74·95	75·69	76·14	76·39	76·37
	1883	75·85	75·02	74·28	73·89	73·97	73·96	74·32	74·90	75·66	76·16	76·28	76·12
	1884	75·20	74·39	73·90	73·64	73·65	73·95	74·34	76·00	76·87	77·33	†77·27	76·72
	1885	75·83	74·95	74·34	74·00	73·92	74·02	74·25	‡	‡	‡	‡	‡
	1886	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡
	1887	(a)74·58	74·67	74·30	73·80	73·50	73·55	73·95	75·05	76·01	76·20	76·28	76·20
	1888	75·90	75·49	74·87	74·22	73·87	73·83	74·10	(h)75·26	76·44	76·97	77·10	76·87
	1889	76·55	76·00	75·39	74·71	74·25	74·17	74·59	76·63	77·67	...	...	...
12·8	1881	...	...	...	...	...	74·87	76·47	77·88	78·98	79·26	77·71	74·89
	1882	72·33	70·79	70·47	71·70	73·37	75·23	76·87	78·20	78·98	79·02	77·64	74·89
	1883	72·46	70·36	69·83	70·94	73·00	75·17	76·82	78·20	78·97	78·93	76·93	73·50
	1884	70·95	69·75	70·04	71·47	73·39	75·75	77·42	79·24	79·82	79·34	§77·08	74·52
	1885	72·18	70·37	70·03	71·14	72·66	73·99	76·09	78·98	79·42	79·25	77·93	75·36
	1886	72·49	(b)70·56	70·26	70·95	72·46	74·12	76·18	78·63	79·54	79·41	77·82	75·16
	1887 Old	(c)72·56											
	1887 New	(d)69·22	68·80	69·67	71·12	73·38	76·09	77·65	79·23	79·77	79·30	77·08	74·10
	1887	72·16	70·87	70·18	70·97	72·87	75·37	77·20	78·94	79·58	79·25	78·27	76·50
	1888	74·25	72·12	70·73	71·25	73·05	75·18	77·27	79·23	80·13	79·78	78·62	76·77
	1889	74·43	72·58	71·16	71·42	73·25	75·26	77·75	80·81	80·81	...	...	...
6·4	1881	...	...	...	...	...	80·66	81·01	80·75	81·24	80·33	75·80	70·58
	1882	67·17	66·06	67·75	72·29	76·47	80·01	80·78	81·30	81·32	80·16	75·75	71·03
	1883	67·64	65·10	66·48	71·00	76·72	79·29	80·70	81·42	81·12	79·50	74·50	68·71
	1884	66·03	65·61	67·95	72·36	76·99	80·76	81·46	81·64	81·10	78·85	73·81	69·57
	1885	66·64	64·83	66·73	71·10	74·29	77·59	80·32	80·77	80·85	79·90	76·19	70·97
	1886	66·53	64·72	66·61	69·99	74·87	77·87	80·34	81·54	81·70	79·92	75·50	70·69
	1887 ¶ Old	65·79	64·16	67·63	71·40	76·96	80·23	80·57	81·08	80·89	79·43	75·33	71·10
	1887 New	(e)64·65	64·54	67·58	71·72	77·91	80·94	80·86	81·11	80·88	79·58	75·94	71·97
	1888	67·67	64·78	67·04	71·91	76·84	80·67	82·14	81·79	81·50	79·50	76·13	71·11
	1889	67·90	66·06	67·03	71·99	77·32	80·30	81·69	82·16	81·64	...	...	...
3·2	1881	...	...	...	...	...	85·93	83·29	82·03	82·40	79·67	72·20	65·59
	1882	62·57	62·31	67·61	75·49	80·86	84·77	82·71	83·04	82·20	79·21	71·73	66·14
	1883	62·27	60·70	64·83	74·13	81·57	83·44	83·00	83·43	81·74	78·23	69·72	62·50
	1884	61·23	61·90	67·69	75·75	82·32	85·11	84·20	81·94	81·38	76·50	69·32	64·48
	1885	61·38	60·28	65·97	73·52	76·30	82·30	82·68	80·94	81·35	78·73	72·55	65·37
	1886	60·79	60·22	65·33	72·39	78·89	82·14	82·55	82·48	82·37	78·44	71·74	65·56
	1887	(f)61·70 / 58·57	59·99	68·80	76·55	85·47	84·93	82·56	81·63	81·31	78·23	72·08	66·91
	1888	61·77	60·46	67·93	76·58	82·31	86·18	83·84	82·53	81·14	77·40	72·17	65·08
	1889	63·08	61·44	67·15	76·50	82·22	84·71	83·47	82·39	81·58	...	...	...
1·1	1881	...	...	...	...	...	89·16	84·14	82·55	83·19	77·81	67·81	60·72
	1882	58·91	59·41	69·50	78·88	84·99	88·24	83·48	84·08	82·89	77·85	67·96	62·17
	1883	57·98	58·45	65·87	79·53	86·65	87·94	84·55	84·89	82·19	76·70	65·41	57·83
	1884	58·28	59·89	69·56	80·14	88·27	88·57	85·59	82·03	81·64	74·14	65·38	60·10
	1885	57·35	57·75	68·28	77·20	78·63	87·22	84·35	81·16	82·09	77·45	69·03	60·91
	1886	57·13	57·76	66·25	77·19	83·02	86·44	83·78	82·99	83·16	76·78	68·36	61·20
	1887	55·80	58·16	69·27	79·12	89·25	85·94	82·73	81·34	81·01	75·79	67·54	61·31
	1888	55·79	57·31	(g)67·20 / 71·80	79·87	85·75	89·71	83·34	82·81	80·38	74·47	67·27	57·96
	1889	57·34	57·77	67·87	78·88	84·09	87·94	83·98	82·53	80·84	...	...	...
Thermometer in shade.	1881	...	...	...	...	...	87·68	82·54	81·00	82·86	82·72	75·22	71·19
	1882	66·77	66·51	81·36	88·72	91·04	89·11	81·61	82·40	84·62	83·47	75·04	72·36
	1883	64·80	68·72	75·89	91·83	95·54	90·60	83·54	83·85	82·86	82·00	70·95	66·12
	1884	67·36	68·52	81·32	89·51	97·33	89·69	83·86	79·73	80·30	77·30	71·77	67·37
	1885	62·50	65·44	79·35	85·63	84·47	91·97	82·74	79·08	82·41	81·98	75·09	66·31
	1886	63·04	67·49	73·74	88·55	87·82	90·60	82·35	81·75	85·05	80·90	74·56	68·93
	1887	59·79	70·61	80·37	89·88	98·66	89·09	81·28	78·60	83·34	80·03	74·73	67·50
	1888	62·74	66·99	81·89	91·99	95·80	96·33	82·21	80·27	81·74	79·53	71·36	67·54
	1889	65 27	65·54	81·04	91·46	93·08	90·18	81·86	81·27	82·12	...	...	...

* The hole, which had gradually filled up about 2½ feet, was dug down to the original depth between the 20th and 24th December 1881.

† The hole, which had gradually filled up 2 feet since December 1881, was dug down to the original depth between the 9th and 18th November 1884.

‡ Earth fell in from the sides of the hole on the 2nd and 3rd August 1885, and covered the thermometer to the depth of 11 feet. It was found impossible to sink another thermometer to this depth till 20th January 1887, when a new hole was dug down to the depth of 25·6 feet and lined with 4-inch stoneware pipes.

(*a*) This is the mean of the readings of the last 11 days of the month.

§ The hole, which had gradually filled up 11 inches since June 1881, was dug down to the original depth on the 17th and 18th November 1884.

(*b*) When the 25-foot hole filled up in August 1885, the 12-foot hole, which was close by, deepened about a foot, and the length of chain being greater than necessary, the thermometer remained suspended at a depth of 14 feet till 23rd January 1887, when the hole was filled up till it was only 12·8 feet deep. At the same time a new hole was dug to this depth and lined with 4-inch stoneware pipes. Readings from both have been regularly taken for the sake of comparison.

(*c*) This is the mean of the readings of a 14-feet deep thermometer for the first 23 days of the month.

(*d*) This is the mean of the readings of a 12·8 feet deep thermometer on the last 7 days of the month.

¶ A new hole was dug in January 1887 and lined with stoneware pipes, but the old hole was left undisturbed for the sake of comparing the readings.

(*e*) This is the mean of the readings of the last 7 days of the month.

(*f*) This is the mean of the readings of the first 13 days of the month, after which a new hole was sunk lined with 4-inch stoneware piping, and the reading below is for the last 14 days of the month.

(*g*) This is the mean of the readings of the first 20 days of the month, after which a new hole was sunk lined with 4-inch stoneware piping, and the reading below is for the last 11 days of the month.

(*h*) Mean of 25 days of the month, the instrument being out of order from 11th to 16th August.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Mean velocity in miles of the Winds which blew at Dehra Dun during the twelve months of 1888-89, for each hour of the day.

Civil Hours.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
0 to 1	1·46	1·00	0·32	0·58	0·75	1·90	2·50	1·58	1·07	0·63	0·52	1·04
1 „ 2	1·36	1·14	0·13	0·74	0·71	1·61	2·50	1·97	1·24	0·80	0·90	0·93
2 „ 3	0·96	1·03	0·10	0·42	0·79	1·45	2·17	2·06	0·90	0·60	0·59	0·96
3 „ 4	0·64	0·69	0·07	0·48	0·57	1·16	1·83	1·74	1·00	0·52	0·45	0·82
4 „ 5	0·93	0·79	0·00	0·77	0·89	1·10	2·10	1·42	1·07	0·62	0·31	0·64
5 „ 6	0·54	0·41	0·13	0·71	0·64	1·23	1·87	1·42	1·03	0·41	0·34	0·43
6 „ 7	0·86	0·45	0·16	0·45	0·57	0·90	1·33	1·39	0·86	0·28	0·38	0·39
7 „ 8	0·57	0·52	0·13	0·45	0·64	0·52	1·23	1·29	0·97	0·55	0·66	0·71
8 „ 9	0·71	0·38	0·13	0·45	0·64	0·68	1·47	1·87	1·41	0·76	0·79	0·61
9 „ 10	0·79	0·59	0·29	0·77	0·61	1·39	2·03	2·48	1·52	1·24	1·07	1·21
10 „ 11	1·50	1·00	0·58	0·97	0·93	1·74	2·97	3·42	1·72	1·55	1·83	1·36
11 „ 12	1·64	1·31	0·71	0·87	1·25	2·45	3·73	3·39	2·38	1·62	1·86	1·46
12 „ 13	2·00	1·48	0·84	1·65	1·89	2·97	4·57	3·84	2·46	1·73	1·90	1·50
13 „ 14	2·11	1·90	0·87	1·61	1·93	2·87	5·17	3·90	2·82	2·43	1·83	2·14
14 „ 15	2·07	1·73	0·84	1·77	2·14	3·52	5·07	4·26	3·21	2·50	1·86	1·96
15 „ 16	1·78	1·38	0·81	1·74	2·75	3·13	5·20	4·23	2·71	1·93	1·38	1·97
16 „ 17	0·68	0·90	0·23	1·19	1·93	2·81	4·97	4·10	2·45	2·40	1·34	1·03
17 „ 18	0·18	0·59	0·00	0·61	1·25	1·35	3·77	3·48	1·79	1·53	0·86	0·48
18 „ 19	1·25	0·59	0·03	0·35	0·75	0·29	1·33	2·06	1·28	0·90	0·41	0·83
19 „ 20	1·96	1·03	0·29	0·42	0·50	0·77	1·70	1·81	0·83	0·53	0·31	1·14
20 „ 21	2·11	1·21	0·42	0·42	0·36	1·29	2·27	1·61	0·93	0·77	0·24	1·14
21 „ 22	2·11	1·48	0·35	0·42	0·61	1·84	2·53	1·94	1·14	0·30	0·59	1·39
22 „ 23	2·04	1·14	0·45	0·48	0·75	1·81	2·67	2·26	0·76	0·47	0·34	1·04
23 „ 24	2·04	1·52	0·23	0·74	1·21	2·20	2·70	2·29	0·93	1·03	0·48	1·36
Sums	32·29	24·26	8·11	19·06	25·06	40·98	67·68	59·81	36·48	26·10	21·24	26·54
Average	1·35	1·01	0·34	0·79	1·04	1·71	2·82	2·49	1·52	1·09	0·89	1·11

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Monthly Meteorological Results taken from the Register at the

Year and Month.	Barometer reduced to 32° Fahrenheit.						Hygrometer.	
	At 9-30 A.M.			At 3-30 P.M.			At 9-30 A.M.	At 3-30 P.M.
	Highest.	Lowest.	Monthly mean.	Highest.	Lowest.	Monthly mean.	Monthly mean humidity.	Monthly mean humidity.
1888.								
October	27·879	27·577	27·740	27·787	27·529	27·690	0·59	0·48
November	·927	·653	·802	·881	·592	·726	·62	·52
December	·940	·732	·837	·849	·657	·759	·62	44
1889.								
January	·950	·517	·811	·846	·520	·735	·60	·45
February	·867	·675	·770	·834	·607	·711	·70	·53
March	·882	·605	·735	·808	·531	·661	·50	·33
April	·732	·399	·598	·715	·311	·520	·33	·21
May	647	·396	·533	·587	·315	·467	·32	·23
June	·519	·272	·399	·523	·165	·324	·61	·58
July	·515	·251	·394	·455	·201	·328	·84	·82
August	·564	·308	·433	·435	·214	·356	·87	·83
September	·635	·444	·549	·636	·369	·472	·75	·69

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Trigonometrical Branch Office, Dehra Dun.

THERMOMETER.								RAIN.		WIND.	CLOUD.	
DRY BULB.					WET BULB.							
Maximum in sun's rays.	Minimum on grass.	Maximum in air.	Minimum in air.	Monthly mean in air.	Maximum.	Minimum.	Monthly mean.	Number of days it fell.	Fall in inches.	Most frequent direction.	At 9-30 A.M.	At 3-30 P.M.
142·1	45·4	85·6	53·7	70·6	77·7	49·7	62·7	3	0·39	Calm	2	2
135·9	37·5	80·0	43·9	64·0	67·8	42·9	56·8	5	1·81	Calm	2	4
126·0	33·2	73·5	40·6	57·7	60·7	38·7	50·8	1	0·25	Calm	1	1
131·5	32·9	76·5	40·8	57·3	62·0	37·9	50·5	7	3·07	Calm	4	5
133·5	28·7	78·0	35·0	58·0	63·5	34·3	52·3	8	4·58	Calm	4	6
144·4	42·3	88·9	48·6	69·8	77·0	46·2	59·9	*Nil*	*Nil*	Calm	2	3
155·3	47·4	103·6	57·1	79·7	76·8	50·3	64·1	*Nil*	*Nil*	W.S.W.	2	3
159·0	55·9	102·1	62·5	82·2	77·6	52·6	65·7	5	1·69	W.	4	4
157·3	66·4	105·9	68·2	84·0	82·1	58·0	74·0	15	14·27	Calm	5	5
158·7	66·2	89·9	70·3	79·5	83·7	64·2	76·0	27	43·54	Calm	8	8
157·0	68·0	91·9	70·5	78·8	82·3	68·8	75·4	29	34·76	Calm	8	8
154·9	54·6	86·8	61·9	77·0	80·4	56·7	71·2	16	7·55	Calm	4	5

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

TYPE-PRINTING SECTION.—With the exception of a trifling amount of work done for other Departments, the energies of this section have been entirely devoted to the publication of the records of this Branch of the Survey Department and work connected with the office.

Hitherto the Forms for use with the Tidal and Levelling Party were procured elsewhere; but now a proportion of them are printed in this office, and this has thrown a good deal of extra work on the Type section. The following tabular statements show the money value of the work performed by this section :—

Statement of expenditure (Dr.) and amounts credited (Cr.) during the year 1888-89.

DR.			CR.		
	₹	₹		₹	₹
Superintendence	770		Departmental work, letter-press, forms, diagrams, &c.	14,825	
Establishment	8,350				14,825
Aid rendered by Computing section	4,326				
Wear and tear of plant	492				
Contingencies	104				
		14,042	Miscellaneous letter-press, &c., extra-departmental work	58	
Stores received from England	85				58
		85			
Stores purchased in India	...				
Stationery from Stationery Office	756				
		756			
TOTAL	...	14,883	TOTAL	...	14,883

Statement of Departmental work during the year 1888-89.

SPECIFICATION OF PRINT.	Number of pages.	Total number of pulls.	Number of copies.*	Value.
				₹
Professional Volumes	649	116,658	510	8,730
Synoptical Volumes	107	11,186	360	1,266
Pamphlets of spirit-levelled heights	72	7,010	510	650
Letter-press for charts, map headings and foot-notes	108	2,747	30	460
Auxiliary Tables	3	170	1,052	43
Library Catalogue	117	4,376	82	183
Forms	186	17,526	160	2,033
Exploration	67	2,955	150	273
Miscellaneous	186	34,020	Not obtainable.	1,172
Index to Circular Orders	4	1,288	404	15
TOTAL	1,499†	197,936	...	14,825

* Approximate number.

† Equal to 1,989 pages of standard (foolscap) size.

Statement showing the amount and value of work done for other Departments during the year 1888-89.

Departments.	Number of pages.	Total number of pulls.	Number of copies.	Value.
				₹
Forest Department	21	978	Not obtainable.	58
TOTAL	21‡	978	...	58

‡ Equal to 16 pages of standard (foolscap) size.

The usual table showing the work annually performed by this section during the past five years is given below, the unit (a page of foolscap) being the same throughout—

	1884-85.	1885-86.	1886-87.	1887-88.	1888-89.
Pages composed	1,505	1,340	1,516	1,994	1,989
„ printed	470,970	638,593	805,076	708,506	782,286

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

An analysis of the pages composed is as follows:—

		Pages.
Professional	Longitude operations	128
	Latitude operations	832
	Great Arc Series Section, 8° to 18°	75
	Bombay Longitudinal Series	67
	South Konkan Coast Series	*24
	Madras Longitudinal Series	6
	Mangalore Meridional Series	12
	Introductory Chapters	27
	Singi Meridional Series	56
	Khanpisura Meridional Series	4
	Abu Meridional Series	10
	Kattywar Meridional Series	17
	Cutch Coast Series	8
	Total	1,266
Synoptical	Afghan Boundary Commission volume	33
	Bombay Longitudinal Series	16
	Singi Meridional Series	19
	Khanpisura Meridional Series	4
	Abu Meridional Series	10
	Kattywar Meridional Series	17
	Cutch Coast Series	8
	Total	107
Miscellaneous	Spirit-levelled Heights	72
	Letter-press for charts, map-headings and foot-notes	67
	Auxiliary Tables	5
	Library Catalogue	134
	Forms, Orders, Memoranda	223
	Explorations	99
	For Forest Department	16
	Total	616

Photo-zincographic Section.—This section has been employed in printing maps, charts, diagrams, &c., both to illustrate the volumes published by the office and for general use, also in printing from zinc the departmental professional forms in which mathematical formulæ are largely employed; it has also executed a large amount of extra-departmental work, as will be seen on reference to the second of the following tables; indeed nearly half the work done has been for other Departments.

For the better printing of maps in two colours, which was advocated last year, a large camera for taking negatives 24″ × 24″ was transferred from Calcutta; but the use of it has been hitherto much restricted by the small quantity of glass available. The Director General of Stores has been specially asked to expedite the necessary supply.

The following statements exhibit the value and out-turn of work done in this section:—

Statement of expenditure (Dr.) and amounts credited (Cr.) during the year 1888-89.

Dr.			Cr.		
	R	R		R	R
Superintendence	2,400	...	Departmental Maps, Forms, Diagrams, &c.	9,894	9,894
Establishment	8,508	...			
Contingencies	469	11,377			
Chemicals and stores from England	*5,400	...			
Paper received from England	930	6,330			
Chemicals and stores purchased in India	114	...	Miscellaneous Maps, Plans, &c., extra-departmental	7,469	7,469
Stationery (papers) from Stationery Office	994	1,108			
			Balance to debit of Department	1,477	1,477
Shipping and Landing charges	25	25			
Total	...	18,840	Total	...	18,840

* This sum includes the cost (nearly R 2,000) of a large quantity of glass not yet expended.

Note.—In addition to the credits above shown, the section has realized by sale, on payment, of maps, &c., and paid into the treasury the sum of R988-7-0.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Statement showing the amount and value of work done for other Departments, &c., during the year 1888-89.

Departments, &c.	Photo-zincographic Printing.								Value.	Remarks.
	Sheets or sections or subjects.	Negatives.	Photo-transfer Prints.	Zinc Plates.	Silver Prints.	Blue Prints.	Pulls.	Copies.		
									R a.	
Forest Department . .	70	239	278	57	26	1	3,385	4,514	3,596 0	(a) Already realised and included in the sums paid into the Treasury as given in note to the Dr. Cr. Statement.
Foreign ditto . .	1	4	4	1	...	...	20	20	51 15	
Military ditto (Sikkim Field Force).	1	6	6	1	...	...	40	40	76 12	
Quartermaster General .	25	127	296	26	...	...	8,035	7,241	3,458 4	
Executive Engineer, Dehra Dun.	139	...	...	...	...	139	...	139	(a)69 8	
Mobilization Committee, Simla.	1	12	12	2	...	...	614	307	216 12	
Total .	237	388	596	87	26	140	12,094	12,261	7,469 3	

Statement of Departmental Work done during the year 1888-89.

Specification of Plate or Print.	Photo-zincographic Printing.												Remarks.
	Progress made.	Scale of maps.	Size of each sheet.	Sheets or subjects.	Negatives.	Photo-transfer prints.	Zinc plates.	Silver prints.	Blue prints.	Pulls.	Copies.	Value.	
												₹ a.	
Bangalore City, Cantonment and Environs Nos. 3 to 13	* F	1 inch = $\frac{1}{12}$ m.	D. E.	11	...	...	11	...	...	572	572	123 6	
Central Provinces Forest Survey, Sheet No. 18 $\frac{S.W.}{2}$ and $\frac{S.W.}{4}$	,,	$\frac{1}{4}$,,	$\frac{1}{8}$,,	2	2	2	1	...	...	8	16	28 9	For Office use.
Chart of the Spirit-levelling Operations in Hooghly and Nuddea districts (season 1887-88)	,,	12 ,,	$\frac{1}{16}$,,	1	1	8	1	...	...	68	544	58 0	For Pamphlet of Spirit-levelled Heights in Bengal Presidency.
Chart of the Spirit-levelling Operations in Madras Presidency (season 1887-88)	,,	16 ,,	$\frac{1}{2}$,,	1	3	6	1	...	...	265	530	88 4	For Pamphlet of Spirit-levelled Heights No. 4 Madras Presidency.
Darjeeling Survey, Portion of Daling Hills, Sheet No. 1	In Press	$\frac{1}{8}$,,	,,	1	8	...	1	...	...	...	...	45 10	
Do. do. No. 2	,,	$\frac{1}{8}$,,	,,	1	6	...	1	...	...	...	...	34 3	
Do. do. No. 3	,,	$\frac{1}{8}$,,	,,	1	8	...	1	...	...	...	..	45 10	
Do. do. No. 4	,,	$\frac{1}{8}$,,	,,	1	8	...	1	...	...	...	...	45 10	
Do. do. No. 5	,,	$\frac{1}{8}$,,	,,	1	8	...	1	...	...	...	...	45 10	
Do. do. No. 6	,,	$\frac{1}{8}$,,	,,	1	8	...	1	...	...	...	...	45 10	
Diagram of North-East Quadrilateral } Corner slips	F	48 ,,	$\frac{1}{16}$,,	2	1	15	1	...	...	35	{ 525 } { 525 }	70 13	For New Map Catalogue.
Do. do. North-West do. }	,,	...	$\frac{1}{8}$,,	1	1	4	1	...	...	133	532	36 10	For Professional Volume.
Do. do. Personal Equation	,,	48 ,,	$\frac{1}{8}$,,	1	...	...	1	...	...	220	220	31 11	For New Map Catalogue.
Do. do. Triangulation east of 92°	,,	...	$\frac{1}{4}$,,	1	2	4	1	...	...	110	220	45 10	} For Hand-book, Trigl. Branch.
Do. showing Chronographic Record	,,	...	$\frac{1}{4}$,,	1	1	1	1	...	...	3	3	11 10	} For Hand-book, Trigl. Branch.
Do. do. (experimental)	In Press & F	...	...	10	1	34	10	...	...	934	1,454	332 10	
Forms for Departmental use,—Miscellaneous	,,	...	...	26	13	228	26	...	...	9,114	10,668	2,407 1	
Do. Professional	* ,,	1 ,,	D. E.	1	...	9	1	...	...	75	* 75	64 14	
Gujarat Survey Sheet No. 7	* ,,	1 ,,	,,	1	9	9	1	...	...	75	75	116 3	
Do. No. 9	*In Press	1 ,,	,,	1	9	9	1	...	...	...	...	97 13	
Do. No. 26	* F	1 ,,	,,	1	...	9	1	...	...	56	56	62 8	
Do. No. 77	* ,,	1 ,,	,,	1	...	9	1	...	...	50	50	57 4	
Do. No. 78	* ,,	1 ,,	,,	1	...	9	1	...	...	50	50	57 4	
Do. No. 79	*In Press	1 ,,	,,	1	2	18	1	...	...	50	50	115 2	
Do. No. 80	F	64 ,,	,,	1	...	12	2	...	...	530	530	128 8	For New Map Catalogue.
Index to Level Charts and Data	,,	64 ,,	,,	1	...	16	1	...	...	100	100	97 3	
Do. the Charts of the Coast Triangulation	,,	192 ,,	$\frac{1}{8}$,,	1	...	4	2	...	...	275	550	47 12	For New Map Catalogue.
Do. the Groups of the Principal Triangulation	In Press	2 ,,	,,	1	6	...	...	...	...	...	...	34 3	
Level Charts No. 66 (2nd Edition)	F	2 ,,	,,	1	...	6	1	...	...	80	80	52 0	
Do. No. 81 { do. }	,,	...	$\frac{1}{8}$,,	5	3	6	1	...	...	54	540	60 7	
Do. do. { do. }, Bench-marks	,,	2 ,,	,,	1	...	6	1	...	...	80	80	52 0	
Do. No. 83 { do. }	,,	...	$\frac{1}{8}$,,	1	1	4	1	...	...	25	100	33 14	
Do. do. { do. }, Bench-marks													

Statemen of Departmental Work done during the year 1888-89—continued.

Specification of Plate or Print.	Photo-zincographic Printing.									Pulls.	Copies.	Value.	Remarks.
	Progress made.	Scale of maps.	Size of each sheet.	Sheets or subjects.	Negatives.	Photo transfer prints.	Zinc plates.	Silver prints.	Blue prints.				
												R a.	
Mirzapur Survey Sheet No. 184 S.E.	F	1 inch = ½ m.	D. E.	1	...	6	1	...	...	150	150	65 4	
Do. No. 185 S.E.	,,	½ ,,	,,	1	12	18	2	...	...	308	154	213 10	
Do. No. 200 N.E.	,,	½ ,,	,,	1	6	6	1	...	...	150	150	99 7	
Do. No. 200 S.W.	,,	1 ,,	¼ ,,	1	2	2	1	...	...	3	3	25 5	For Office use.
Do. No. 200 S.W.	,,	½ ,,	,,	1	6	6	1	...	...	152	152	99 11	
Do. No. 201	,,	1 ,,	,,	1	...	9	1	...	...	80	80	65 9	
North-East Trans-Frontier Sheet No. 6	,,	8 ,,	,,	1	7	7	1	...	...	160	160	99 14	For Exploration Report.
Do. No. 7	,,	8 ,,	,,	1	10	45	1	...	...	232	232	328 4	Do. and issue
Do. No. 7 N.W./1 and part of No. 6	* ,,	2 ,,	,,	1	...	...	1	...	...	25	25	7 10	
Do. No. 7 N.W./3	* ,,	2 ,,	,,	1	...	...	1	...	...	25	25	7 10	
Plan of the Trigonometrical Operations in the Nizam's Dominions (portion of)	F	2 ,,	¼ ,,	1	2	...	...	...	2	,,,	1	12 10	For Office use.
Plan of the Trigonometrical Survey of Kistna-Tungabhadra Doáb	,,	8 ,,	,,	1	6	6	1	...	...	14	14	72 7	
Plates of the Abu Meridional Series	,,	12 ,,	,,	1	...	4	1	...	...	133	532	45 3	
Do. Cutch Coast Series	In Press	12 ,,	,,	2	2	...	...	...	...	...	...	11 6	For Professional Volume of South-West Quadrilateral.
Do. Kattywar Series	F	12 ,,	,,	1	...	4	1	...	...	133	532	45 4	
Do. Khanpisura Meridional Series	,,	12 ,,	,,	2	...	8	2	...	...	266	1,064	90 12	
Do. Madras Longitudinal Series	,,	12 ,,	,,	1	...	4	1	...	...	65	260	34 2	For Professional Volume of Southern Trigon.
Do. South-East Coast Series	In Press	12 ,,	,,	2	2	4	1	...	...	...	...	34 13	
Do. Scales appertaining to the above Plates	F	...	,,	1	1	4	1	...	...	13	936	32 5	
Quetta Civil Station Sheet No. 1	,,	1/8 m.	,,	1	6	6	1	...	...	150	150	99 7	
Do. do. No. 2	,,	1/8 ,,	,,		6	6	1	...	...	150	150	99 7	
Reduction Chart of Southern Trigon (portion of)	,,	...	1/8 ,,		1	2	1	...	...	2	2	12 0	For Office use.
Secondary Triangulation,—Chart of the East Coast Series, No. 10	,,	2 m.	,,	1	6	6	1	...	...	20	20	74 3	
Secondary Triangulation,—Chart of the East Coast Series, No. 11	,,	2 ,,	,,	1	6	6	1	...	...	20	20	74 3	
Secondary Triangulation,—Chart of the East Coast Series, No. 14	,,	2 ,,	,,	1	6	6	1	...	...	20	20	74 3	Provisional issue.
Secondary Triangulation,—Chart of the East Coast Series, No. 15	,,	2 ,,	,,	1	6	6	1	...	...	20	20	74 3	
Secondary Triangulation,—Chart of the East Coast Series, No. 16	,,	2 ,,	,,	1	6	6	1	...	...	20	20	74 3	
Sketch Map to illustrate course of the Lower Sángpo	,,	12 ,,	½ ,,	1	...	...	1	...	...	162	162	16 4	or Exploration Report.
Table of Distances in Links corresponding to a 20-feet Subtense	,,	...	1/8 ,,	2	1	8	1	...	...	110	110	57 6	For Departmental use.
Other Maps for Office use, Surveyor-General's Office, &c.	In Press and F	...	...	49	205	200	43	...	77	3,003	2,075	2,843 9	

Work done for other Departments during the year 1888-89.

Famunpokri Forest Reserve, Kurseong Sub-Division, Bengal	F	½ m.	½ D. E.	1	4	8	1	...	...	7	14	2	9
Forests of Bernardmyo and Ruby Mines Valleys	,,	1 ,,	¼ ,,	1	2	4	1	...	...	8	16	3	4
Do.- Maingwun Pyaungthwe, district Yeu (Burma)	,,	1 ,,	,,	1	8	8	1	...	...	15	15	6	6
Forest Surveys in Berar, Sheets Nos. 19 $\frac{N.\ W.}{1}$, 19 $\frac{N.\ W.}{2}$, 20 N. E., 20a N. E., 26 $\frac{N.\ W.}{3}$, 26 $\frac{S.\ W.}{1}$, 26 $\frac{S.\ W.}{3}$, 26 $\frac{S.\ W.}{4}$	,,	½ ,,	,,	8	54	54	8	...	...	120	120	51	0
Forest Surveys in Chota Nagpur, Sheets Nos. 116 $\frac{S.\ E.}{4}$, 127 $\frac{N.\ E.}{1}$, 127 $\frac{N.\ E.}{3}$, 127 $\frac{S.\ E.}{2}$, 127 $\frac{S.\ E.}{2}$, 158 $\frac{N.\ W.}{1}$	,,	½ ,,	,,	6	6	26	6	...	...	90	90	38	4
Forest Surveys in Kheri, Sheet No. 114 W.	,,	½ ,,	,,	1	6	6	1	...	...	15	15	6	6
Do. in Kumaun and Garhwál, Sheets Nos. III, VI, VII, XI, LXXV, LXXVI	,,	½ ,,	,,	6	41	41	6	...	...	90	90	38	4
Forest Surveys in Kumaun and Garhwal, Sheets Nos. XXX, LXIII	,,	½ ,,	½ ,,	2	4	4	1	...	...	15	30	5	6
Forest Surveys in Simla, Sheets No. 333, part of 333 $\frac{N.\ W.}{3, 4}$	,,	½ ,,	,,	1	...	...	1	...	...	30	15	10	14
Forest Triangulation in Kumaun and Garhwál, Charts Nos. I, IV	,,	1 ,,	,,	2	...	12	2	...	...	30	30	12	12
Index to the Forest Survey of Bashahr	,,	4 ,,	,,	1	6	12	2	...	...	15	15	5	2
Do. do. Jubbulpore	,,	8 ,,	¼ ,,	1	2	4	1	...	...	8	16	1	13
Do. do. Raipur	,,	8 ,,	¼ ,,	1	4	4	1	...	...	15	15	3	10
Leased Forests in Chamba State	,,	¼ ,,	¼ ,,	1	4	8	1	...	...	8	16	3	4
Do. do. , Bakloh	,,	¼ ,,	¼ ,,	1	2	4	1	...	...	7	14	3	2
Do. do. , Bandharbani	,,	¼ ,,	¼ ,,	1	4	4	1	...	...	15	15	4	0
Do. do. , Chatri	,,	¼ ,,	¼ ,,	1	2	4	1	...	...	7	14	3	2
Do. do. , Kainthli	,,	¼ ,,	¼ ,,	1	1	2	1	...	...	8	16	2	0
Do. do. , Kangu	,,	¼ ,,	¼ ,,	1	3	6	1	...	...	7	* 14	3	2
North-East Trans-Frontier Sheet No. 7 N. W.	,,	4 ,,	,,	1	6	6	1	...	2	31	33	13	15
Teak Forest of Western Pyinmana (Burma)	,,	2 ,,	,,	1	6	6	1	...	...	15	15	6	6
Thanala Forest (Chamba)	,,	¼ ,,	⅛ ,,	1	1	4	1	...	...	4	16	2	12
Other Maps	,,	4 & 16 ,,	D. E. & ½ D. E.	12	58	178	13	...	...	242	158	202	10
TOTAL	...	...	...	164	406	813	149	...	81	19,350	26,156	9,893	9

Copies retained, *for office record*, of maps, &c., requisitioned for by other departments; the cost of press-pulls and stationery being all that is here charged to the Survey Department: the numbers in columns 5 to 8 therefore stand *excluded* from the totals.

* Additional prints of previous publications.—D. E. represents Double Elephant; F. represents Finished.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

SOLAR PHOTOGRAPHIC SECTION.—This section comprises a photographer and four *khalásis;* the photographer has two photo-helios in his charge, one giving 8-inch pictures and the other 12-inch. With the former he has to take two negatives each day that the sun is visible, except on Sundays, when one negative is taken; the latter he only uses when special phenomena are visible on the surface of the sun. The four following tables give the details of the work done in this section :—

Statement of expenditure (Dr.) and amounts credited (Cr.) during the year 1888-89.

DR.	R	R	CR.	R	R
Superintendence	600		Value of negatives and silver prints taken for the Solar Physics Committee, under authority from the Secretary of State for India (debitable to the Industry, Science and Art Departments)	3,350	
Solar Photographer	1,200				3,350
Establishment	308				
Contingencies	873				
		2,981			
Chemicals and Stores received from England	349				
		349			
Chemicals and Stores purchased in India	20				
		20			
Shipping and Landing charges	0				
		0			
TOTAL	...	3,350	TOTAL	...	3,350

Table of Working Facts for the year 1888-89.

1888-89.	NUMBER OF DAYS.				NUMBER OF NEGATIVES.										NUMBER OF WORKING DAYS WHEN SOLAR PHENOMENA WERE	
					Solar Phenomena.								TOTAL.			
	When negatives were taken.	Failures. From bad weather.	Failures. From various causes.	Total.	Spots and Faculæ.		Spots only.		Faculæ only.		None.				Visible.	Absent.
					8″	12″	8″	12″	8″	12″	8″	12″	8″	12″		
October	29	2	...	31	6	...	...	...	28	...	19	...	53	...	18	11
November	28	2	...	30	34	10	6	...	11	...	1	...	52	10	27	1
December	29	2	...	31	20	3	6	...	14	...	12	...	52	3	22	7
January	23	8	...	31	4	...	...	...	12	...	22	...	38	...	9	14
February	22	6	...	28	6	...	9	...	11	...	13	...	39	...	15	7
March	29	2	...	31	10	...	11	...	21	...	10	...	52	...	24	5
April	29	1	...	30	8	...	10	...	10	...	22	...	50	...	15	14
May	30	1	...	31	6	2	4	...	11	...	30	...	51	2	11	19
June	26	4	...	30	19	...	...	...	13	...	13	...	45	...	19	7
July	19	12	...	31	23	...	...	...	3	...	5	...	31	...	16	3
August	22	9	...	31	22	...	8	...	5	...	2	...	37	...	21	1
September	29	1	...	30	21	...	4	...	17	...	5	...	47	...	26	3
TOTAL	315	50	...	365	179	15	58	...	156	...	154	...	547	15	223	92

Six-hundred and fifty-six silver prints of the 8-inch and thirteen of the 12-inch pictures were prepared, and weekly despatches of both silver prints and negatives made as usual to the India Office.

Table contrasting visibility of sun at Dehra Dun and Greenwich.

YEAR.	AT DEHRA DUN.			AT GREENWICH.		REMARKS.
	Number of days on which negatives were taken.	Percentage of days on which negatives showed features.	Number of days when sun was invisible.	Year.	Number of days on which negatives were taken.	
1880-81*	307	96	55	1880	156	* From 1st October to 30th September following.
1881-82	328	100	37	1881	181	
1882-83	318	100	47	1882	221	
1883-84	285	100	78	1883	215	
1884-85	284	100	81	1884	154	
1885-86	290	100	75	1885	206	
1886-87	302	98	61	1886	199	
1887-88	328	91	38	1887	188	
1888-89	315	71	50	1887-88†	182	† Year ending 10th May 1888. Obtained from Report to the Board of Visitors.
Means	306	...	58	...	189	

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

DRAWING SECTION.—The details of the work done in this section are given in the tables which follow :—

Statement of expenditure (Dr.) and amounts credited (Cr.) during the year 1888-89.

Dr.			Cr.		
	₹	₹		₹	₹
Superintendence	12,000	...	Departmental Maps, Charts, &c.	51,913	....
Establishment	42,492	...	Maps, &c., Extra-Departmental	3,209	55,122
Contingencies and travelling allowance	496	...			
Stationery from Stationery Office	134	55,122			
TOTAL	...	55,122	TOTAL	...	55,122

Statement showing the value of work done for other Departments, &c., during the year 1888-89.

Department, &c.	Value.	
	₹	a.
Quarter Master General's Department	2,701	14
Foreign Department	26	0
War Office, Intelligence Division, London	317	8
Forest Survey Office	74	8
Executive Engineer, Rohilkhand Canals	85	2
Executive Engineer, Junágad	4	0
TOTAL	3,209	0

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

DRAWING SECTION.

Statement showing work performed during the year 1888-89.

Title of Map.	Number of Sheets.	Scale.	Remarks.
		In. M.	
General Maps.			
Map of India, Sheet No. 1	1	1 = 32	Compiled in outline for use of Engraving Office, Calcutta.
Afghanistan	4	1 = 24	Additions and corrections made and final press order given.
Standard Maps.			
Darjeeling Survey.			
Sheets Nos. 1 to 7 (Daling Hills)	7	8 = 1	Drawing revised and final press order given.
North-Western Trans-Frontier Series.			
11 Maps	11	1 = 4	Re-examined and additions made.
12 Maps	12	1 = 4	Compiled and final press order given.
2 Maps	2	1 = 2	Ditto ditto.
8 Maps	8	1 = 8	Ditto ditto.
8 Maps	8	1 = 8	In hand.
1 Plan	4	16 = 1	Prepared and final press order given.
1 Index	1	1 = 64	Prepared and printed on both full and half scales.
Northern Trans-Frontier Series.			
1 Map	1	1 = 4	In hand.
South-West Asia Series.			
6 Maps	6	1 = 8	Ditto.
Plans of Cities, Cantonments, &c.			
Quetta Civil Station	2	16 = 1	Completed and final press order given
Index Maps.			
Triangulation of India	1	1 = 96	Corrected up to 1st October 1888 for Annual Report, 1887-88.
Index to Longitude Arcs	1	1 = 96	For Hand-Book Trigonometrical Branch.
Spirit-levelling Operations in Bengal Presidency	1	1 = 16	Drawn on double the scale for reduction to one-half for pamphlet No. 4, Madras Presidency. Final press order given.
Ditto ditto	1	1 = 12	Drawn on treble the scale for reduction to one-third, for pamphlet of Spirit-levelled heights, 1884-89.
N. E. Quadrilateral, N. W. Quadrilateral, S. E. Quadrilateral, S. W. Quadrilateral, Southern Trigon and Triangulation East of 92° of G. T. Survey.	6	1 = 48	Revised and retyped and final press order given.
Miscellaneous Maps, &c.			
Personal Equation Diagram	1	...	Prepared for Professional Volumes. Final press order given.
Diagrams of figures of the following G. T. Series :—			
South-East Coast	2	1 = 12	Prepared on the ¼-inch scale for reduction to one third for Professional Volumes. Final press order given.
Cutch Coast	2		
Forms—Professional	4	...	Prepared and final press order given.
Country about Sadiya	1	1 = 8	Not printed. For use of Rinzin Nimgyal, late Sub-Surveyor.
Mullah's Traverse	2	1 = 4	Re-adjusted for Office use.
Plan of the Printing Office, Dehra Dun	1	...	Not printed.
Diagram of Longitude pillars	1	...	For Hand-Book Trigonometrical Branch.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

DRAWING SECTION.

Statement showing work performed during the year 1888-89—continued.

Title of Map.	Number of Sheets.	Scale.	Remarks.
		In. M.	
Charts.			
Triangulation Chart, South Konkan and Coast Series.	2	1 = 4	In hand. For reduction to one-half scale for Synoptical Volume.
Reduction Chart of Southern Trigon . .	1	1 = 12	In hand. For reduction to one-half scale for Professional Volume.
Triangulation Charts, East Coast Series, Secondary Triangulation Charts Nos. 10, 11, 14, 15 and 16, Provisional issue.	5	1 = 2	Corrected and completed heading, foot-notes, references. Final press order given.
Level Sheet No. 81 (2nd Edition) Parts of Ferozepore, Sirsa, Patiala, Nabha, Montgomery, Bahawalpur and Bickaneer.	1	1 = 2	Revised and additions inserted. Final press order given.
Level Sheet No. 88—Parts of Bahawalpur and Montgomery.	1	1 = 2	In hand.
Trace of Lower Sutlej and Chenab Canals, data, with diagrams and descriptions of Bench-marks.	1	½ = 1	For Office use in compilation of Level Charts.
Diagrams of Bench-marks for Level Sheet No. 66 (2nd Edition).	1	...	Prepared and final press order given.
Maps, coloured	822		

Maps Examined.	Number of Sheets.
General Maps	2
District Maps (portions of)	7
Original Standard Maps	9
Trans-Frontier Maps	33
Index Maps	9
Miscellaneous Maps	30
Tracings of original maps	2
Photographic proofs of Standard Sheets, large scale plans, and various other maps . . .	182
TOTAL .	274

N. B.—In addition to the above, many miscellaneous jobs have been performed, such as assisting in Photographic Office in duffing negatives of Trans-Frontier maps; completing Forest Survey original maps in respect of headings, foot-notes, &c., for press; putting in boundaries of districts on charts for the Computing Office; correcting orthography of names in Trans-Frontier and Route maps.

TRIGONOMETRICAL BRANCH OFFICE DEHRA DUN.

Statement of work done for other Departments, &c., during the year 1888-89.

Title of Map.	Number of Sheets.	Scale.	Remarks.
General Maps.		In. M.	
Map of the Black Mountain . . .	1	1 = 4	Prepared from originals supplied by Foreign Office. Final press order given.
Routes	18	1 = 4	For Quarter Master General. Final press order given.
Map of Persia	6	1 = 16	Revised and corrected for the War Office, Intelligence Division, London.
Graticule Sheets between Latitudes 26° 30′—34° 15′ and Longitudes 46°—57° with points and Coast line.	2	1 = 8	For Quarter Master General.
Charts.			
Data of Levels of Bahala Canals and Eastern Ganges Canal, with descriptions of Bench-marks.	8	Various.	For Executive Engineer, Rohilkhand Canal Division.
Tracing of country around Junágad and Patan.	2	2 = 1	For Executive Engineer, Junágad.
Standard Maps.			
Forest Surveys	43	Various.	Completed headings, foot-notes, references, &c., and final press order given for Forest Survey Branch.
Maps coloured	5,913	Various.	

G. I. C. P. O.—No. 21 S. G.—22-4-90.—450

FILE No. 19.

SERIAL No. 1.

1891.

GOVERNMENT OF INDIA.

REVENUE AND AGRICULTURAL DEPARTMENT.

SURVEYS.

RESOLUTION.

No. 109.

Dated Calcutta, the 14th January 1891.

SUBJECT.

REVIEW of the General Administration Report on the operations of the Survey of India Department for 1888-89.

Government of India Central Printing Office.—No. 937 R. & A.—31-1-91.—350.—S. J. D'S.

No.

Extract from the Proceedings of the Government of India, Revenue and Agricultural Department, No. 109, dated Calcutta, the 14th January 1891.

SURVEYS.

RESOLUTION.

THE operations of the Imperial Survey Department conducted during the year under report by 25 parties, are divided into the three main Sections of Trigonometrical, Topographical and Revenue. The Trigonometrical Surveys are nearly completed in the field, though a large amount of computation remains in the office, and, in the year under report, only five out of the 25 parties were employed on trigonometrical and other scientific surveys. The remaining 20 were employed on topographical and revenue surveys.

2. The Department has enough work before it in the latter classes of survey to occupy it for many years to come, though there is a prospect of a gradual decrease occurring a few years hence. In the meantime, however, the Department is subjected to a severe strain in consequence of the annexation of Upper Burma and the pressing necessity which has arisen for completing the revenue surveys of the Central Provinces and some districts in Bengal within a definite period for purposes of assessment. The possible renewal of operations in the permanently settled districts in Bengal will again expand the programme. No material reduction is likely therefore to be made in the Department for the next five years.

3. The policy, to which considerable effect was given in the year under report, has been to postpone purely topographical surveys in favour of land-revenue surveys, which latter are attended by an immediate enhancement of the revenue of cultivated land within the area surveyed. Thus 17 out of the 20 parties were entrusted with revenue surveys and only three with topographical. The same policy will be continued until the temporarily settled districts in Bengal and Burma have been completed, after which the whole force of the Department will perhaps be available for topographical surveys, the surveys of forests, and if required of the permanently settled districts in Bengal.

4. While the chief efforts of the Department have been thus directed to land-revenue surveys which bring in large returns of revenue, considerable attention has been paid to the reduction of the mileage cost of revenue surveys to the lowest possible level. The total expenditure on revenue surveys has, it is true, been exceptionally high during the last five years, but, on the other hand, a very material reduction has been effected in the mileage cost of cadastral work, the most expensive class of all, at the same time that a very material increase has been made in the area of cadastral operations. The system which is now more or less established was indicated in the Survey Resolution of 1882. The frame work of village maps was to be executed by professional surveyors. Details were to be filled in, if necessary, year after year by village officials. The results were to serve both for topographical and revenue maps. The Government of India have recently issued renewed orders requiring the system to be carried into full effect wherever village maps require further revision, pointing out that, while it

is the most economical in itself, it prevents also the renewal of expenditure in the future. The financial importance of the policy is indicated by the circumstance that the saving effected in the Central Provinces alone is estimated at not less than from 31 to 68 lakhs of rupees. The system requires the strict fulfilment of the policy under which village officials are required to be instructed in field-plotting. This has been effected thoroughly in the Punjab, North-Western and Central Provinces, and measures are being prosecuted, as the Government of India are glad to observe from the present report, with vigour in both Assam and Burma in the same direction. The Madras Government is considering the question of adopting the same policy, and in Bengal as much is being done as is compatible with the absence of organized village establishments. The only Province in which the question has not yet been taken up is Bombay, where the Field Surveys have been practically completed by a separate agency.

5. The thanks of the Government of India are due to Colonel Thuillier and the officers of the Revenue Department for the cordial co-operation which, during the year under report, they have given to the Provincial authorities in their efforts to give practical effect to the policy indicated in the preceding paragraphs. Colonel Steel, whose death the Government of India regret to learn has been recently reported, is among the officers to whom progress in the Central Provinces is due. Colonel Barron, whose retirement has been unfortunately compelled by illness, contributed largely to the development of the system under which survey and revenue officials could most economically work together, and which has now been brought to practical perfection by Colonel Sandeman. Mr. Barrett in Assam and Mr. F. W. Kelly (since retired) in Burma, have zealously co-operated to give effect to the same policy in those provinces.

6. In addition to the three great classes of survey already referred to, some special operations of the Department deserve notice. The tidal observations, which remained for the greater portion of the year under the supervision of Lieutenant-Colonel M. W. Rogers, have attracted considerable attention in Europe, where great value is attached to them. The tidal stations have been recently re-arranged under the advice of Professor Darwin.

7. Geographical explorations and surveys have been actively prosecuted in Upper Burma under the energetic guidance of Major Hobday, and His Excellency the Governor General in Council desires to express his concurrence in the favourable remarks recorded by the Surveyor General on the work accomplished by that officer and his assistants in investigating the topography of the new Province. On the North-Western Frontier also a large amount of valuable reconnaissance survey has been effected by the members of the Baluchistan Party under Lieutenant-Colonel Holdich in addition to their ordinary duties. The exploration carried out during the period under report resulted in improving the geographical knowledge of over 41,000 square miles of country.

8. It remains to notice the work of the Head-Quarters Offices. The Drawing, Photographic, and Lithographic Offices have responded zealously to the ever-increasing demands upon them, and the Drawing Section, under Lieutenant-Colonel C. Strahan, has done excellent work in connection with the Cartography of Upper Burma and trans-frontier countries. Under the able superintendence of Colonel Waterhouse, the Photographic and Lithographic Offices continued to maintain their reputation for high class work. Their removal to commodious accommodation in the Survey buildings will add both to their comfort and

efficiency. The large indents on the Mathematical Instrument Office indicate the importance of that section as an agency of supplying scientific intruments to various Departments of Government.

9. In paragraphs 45 to 47 of his report, the Surveyor General notices the depletion of officers caused by deaths and retirements. The future strength of the senior division of the Survey Department having recently been settled and a programme of operations arranged, the Government of India trust that the difficulties under which the Department has laboured, since the annexation of Burma, will be permanently removed.

10. In the meantime the Government of India desire to acknowledge the difficulty which is represented by the Surveyor General to be caused by the inadequacy of the staff for the duties which the Department is called on to perform. The present strain is due partly to the unexpected loss of officers, partly to the annexation of Upper Burma, and partly to the undue postponement of the Settlement Survey of the Central Provinces. The question of recruitment is one which cannot be dealt with finally until the estimate of survey work remaining in each province is more definitely settled. In the Survey Resolution of 1882 every Province was called upon for a ten years' estimate, but owing to the continuous transition from the former to the present system of survey since that date, as well as to the causes already mentioned, the programme has been constantly altered. Last year, in accordance with the desire of Her Majesty's Secretary of State, expressed in his despatch No. 72 (Pub.-Rec.), dated the 22nd November 1890, a five years' programme was prepared, in accordance with which the operations of the Department are now distributed, but the question of the recruitment of the Department cannot be finally disposed of without an estimate of the work remaining for accomplishment during a much longer period than a single lustrum. The question is further complicated by the obligation which rests upon the State to provide for those deserving officers of the Bombay and Madras Survey Departments who will in the course of the next few years be thrown out of work in those presidencies. The most important element of uncertainty in the programme is the survey of the permanently settled districts in Bengal, for which province, however, now that the most economical method of conducting an operation is being worked out in the surveys of temporarily settled tracts by the Land Records and Survey Departments, it is expected that estimates may shortly be forthcoming. The Government of India will then be in a position to forecast the whole of the surveys still remaining for accomplishment in all provinces, and to gauge definitely the strength of the staff which will be required for their execution.

ORDER.—Ordered that the foregoing Resolution be forwarded to the Surveyor General of India, to the Local Governments and Administrations noted on the margin, and to the Foreign and Military Departments.

Madras.	Punjab.
Bombay.	Central Provinces.
Bengal.	Burma.
North-Western Provinces and Oudh.	Assam.
	Coorg.

Ordered also that it be published in the Supplement to the *Gazette of India*.

(True Extract.)

E. C. BUCK,

Secretary to the Government of India.

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Government of Maharashtra

on 01 February, 2020